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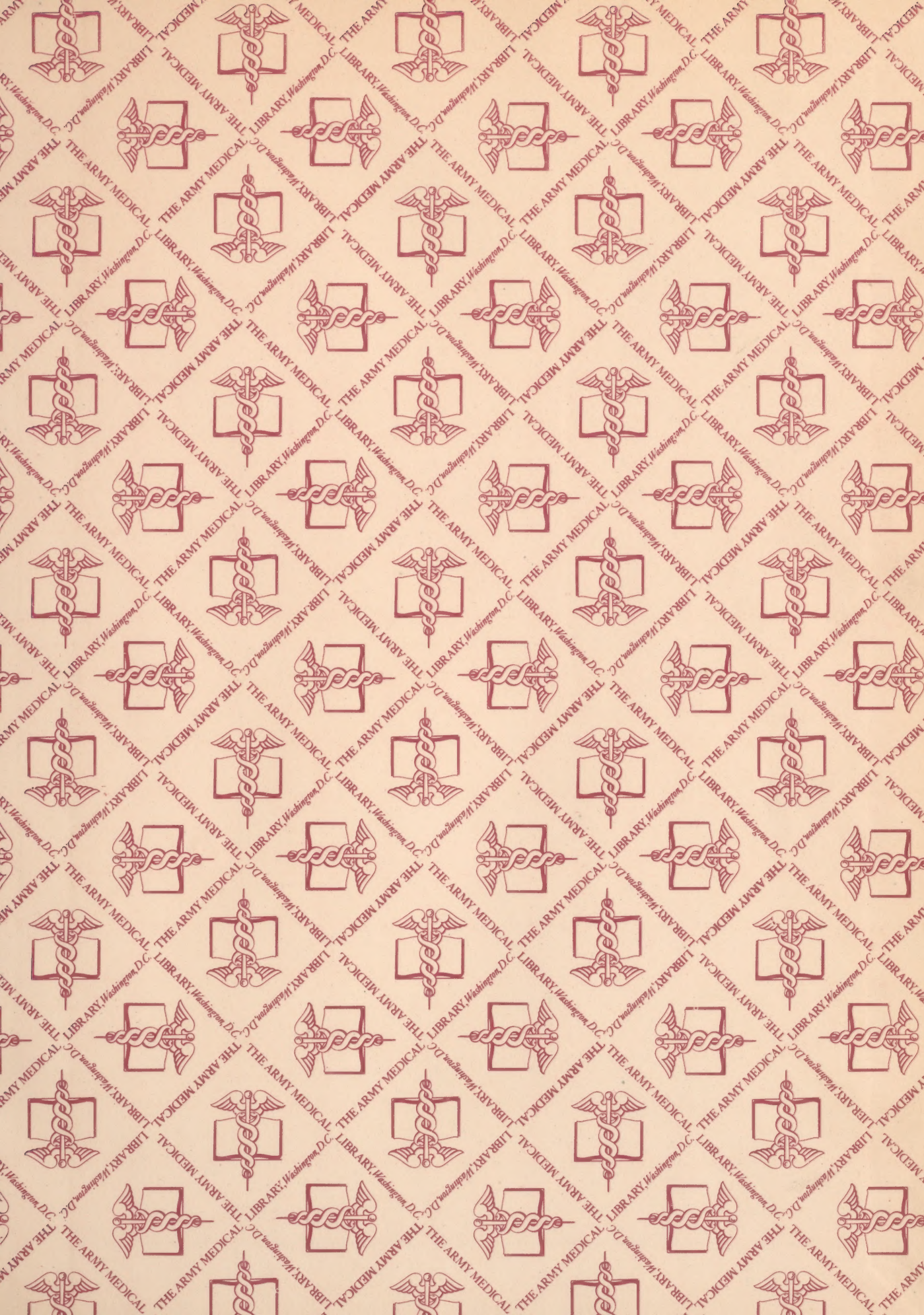


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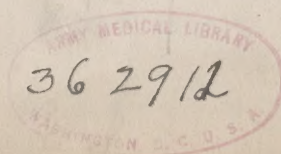
ARITHMETIC FOR MEDICAL TECHNICIANS

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ENLISTED TECHNICIANS SCHOOL

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FOR USE OF STUDENTS

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LINEAR MEASURE

5,280 feet (ft.)	=	1 mile
3 feet	=	1 yard (yd.)
12 inches (in.)	=	1 foot

CAPACITY MEASURE (Apothecaries)

4 quarts (qt.)	=	1 gallon
2 pints (pt.)	=	1 quart
1 pint	=	16 fluidounces ³ / ₈
1 fluidounce	=	8 fl. drams (fl.dr.) ³ / ₈
1 fluidrams		60 minims (m)

WEIGHT MEASURES (Avoirdupois)

2000 pounds (lb.)	=	1 ton
100 pounds	=	1 hundredweight (cwt.)
16 ounces (oz.)	=	1 pound

METRIC AND ENGLISH EQUIVALENTS

1 inch	=	2.54 centimeters (cm.)
1 lb.	=	454 grams (Gm.)
1 meter	=	1.09 yards
1 kilometer	=	0.621 mile
1 kilogram	=	2.20 pounds
1 pint	=	473.18 c.c.
1 fluidounce	=	30.0 c.c. (approximate value)
1 gram	=	15.432 grains (gr.)
1 grain	=	0.0648 gram.

1 cubic centimeter of distilled water at 40° C. weighs 1 gram.

GENERAL NOTES

1. 1000 ft. (1000)
2. 1000 ft. (1000)
3. 1000 ft. (1000)

GENERAL NOTES (continued)

4. 1000 ft. (1000)
5. 1000 ft. (1000)
6. 1000 ft. (1000)
7. 1000 ft. (1000)
8. 1000 ft. (1000)
9. 1000 ft. (1000)

GENERAL NOTES (continued)

10. 1000 ft. (1000)
11. 1000 ft. (1000)
12. 1000 ft. (1000)

GENERAL NOTES (continued)

13. 1000 ft. (1000)
14. 1000 ft. (1000)
15. 1000 ft. (1000)
16. 1000 ft. (1000)
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22. 1000 ft. (1000)

TO THE STUDENT

ARITHMETIC

You have learned to add, subtract, multiply and divide, using integers and common and decimal fractions. You have studied the tables of measures commonly used in the United States. You have learned how to find areas and volumes, and you know something about percentage.

Some of you will remember what you have learned; some will have forgotten; and some perhaps have never learned the basic principles of arithmetic.

This course is mainly for those who have forgotten and those who have never learned. To the rest, it is a good review.

You are to study a very interesting part of arithmetic, one that is of great practical value. You will be interested to learn more of the uses of arithmetic in every day life. The knowledge you acquire from this course will be of value to you throughout your life. Such a knowledge is essential in the store, the shop, the office, the bank, about the mine, on the farm, in chemistry, in engineering, in pharmacy, in medicine, in nursing, and many other vocations and professions.

In each of the vocations and professions one who has not acquired a high degree of accuracy and a reasonable degree of speed in computation is usually at a great disadvantage. Drill exercises, if widely used, will be of value to you because they enable you to increase your speed and accuracy. Strive to excel your own best record. Realize you are working for yourself, and that the knowledge and skill which you acquire will be of great value to you in the years to come.

You will have a difficult time if you do not ask questions about procedures you do not understand. Do not be afraid to ask questions because someone in the class wants to know if the problems can't be worked with calculus. Such questions are ridiculous in such a class as ours, but only the instructor and the questioner usually know it; the other students, becoming discouraged on hearing such awe inspiring questions, do not ask sensible questions for fear of appearing too "dumb." This has been a definite handicap to more than one class of students.

If you are having difficulty, you can improve only by extra hard work, which means practice on problems. Everything new is hard; what is easy is easy because you have learned it by constant drill.

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Chapter 1

READING AND WRITING LARGE NUMBERS

When reading the daily papers and magazines you will often find it necessary to read large numbers. You will recall that, for convenience in reading, large numbers are pointed off into commas as shown in the following example:

14,297,956,480

This number is read fourteen billion, two hundred ninety-seven million, nine hundred fifty-six thousand, four hundred eighty.

The period to the left of billions is called trillions. It is used when expressing great magnitudes, like the distance to one of the stars. The distance from the earth to the Pole Star is more than 250,000,000,000,000 miles. This is read as two hundred fifty trillion miles.

There is a definite way to go about reading such a large number as:

14,297,956,480

Note that every three figures are set off by commas. The first group to the right is known as hundreds. The next to the left, as thousands; the next millions; the last billions. When you see such a number, you should say to yourself as you check each group of three figures, "hundreds, thousands, millions, billions". The next step is to read the whole number. You say fourteen billion, two hundred ninety-seven million, nine hundred fifty-six thousand, four hundred eighty.

Exercise 1

Read the following:

1. The land area of the United States is 3,026,789 and the population in 1940 was 131,669,275.

Read the following land areas and populations:

2. Africa	-	11,529,480	sq. miles;	155,475,000
3. Canada	-	3,694,863	sq. miles;	11,209,000
4. China	-	3,756,102	" "	422,527,000
5. Europe	-	3,773,958	" "	539,800,000
6. India	-	1,575,109	" "	338,170,632
7. Soviet Union	-	8,170,268	" "	180,122,390
8. Asia	-	16,494,217	" "	1,090,314,000
9. Texas	-	265,896	" "	6,414,824
10. Rhode Island	-	1,248	" "	713,346

Read the following distances in Miles:

11.	New York to San Francisco	-	3,173
12.	Earth to Sun	-	92,897,416
13.	Earth to Mercury	-	136,000,000
14.	Earth to Mars	-	248,000,000
15.	Earth to Pluto	-	4,400,000,000
16.	Pluto to Sun	-	3,700,000,000

Read the following areas in square miles:

17.	Atlantic Ocean	-	41,321,000
18.	Pacific Ocean	-	68,634,000
19.	Indian Ocean	-	29,340,000
20.	North Sea	-	220,000
21.	Red Sea	-	178,000
22.	Baltic Sea	-	160,000

23. Mount Everest in Indo China is the highest mountain - 29,141 feet.
24. The deepest place in the ocean yet found is 35,400 feet in the Pacific.
25. The speed of light is 186,324 miles per second.
26. The equatorial circumference of the earth is 24,902 miles.

Accidental deaths in the United States in 1940:

27.	Motor Vehicles	-	34,500
28.	Falls	-	25,600
29.	All burns	-	7,900
30.	Drowning	-	6,300
31.	Railroad	-	5,000
32.	Firearms	-	2,400
33.	Poison Gas	-	1,500
34.	Poisons (not gas)	-	2,100

35. In 1913, deaths from acute accidents amounted to 4,227; from drowning - 9,875.

Read the melting points of the following chemical elements:

36.	Carbon(diamonds)	73,500°	Centigrade
37.	Iron	1,535°	"
38.	Copper	1,083°	"
39.	Lead	327°	"
40.	Molybdenum	2,620°	"
41.	Mercury	38°	

Read the boiling point of the following chemical elements:

42.	Arsenic	615°	Centigrade
43.	Copper	2,300°	"

44.	Hydrogen	.....	-252.8
45.	Iron	.....	3,000
46.	Platinum	.....	760
47.	Thallium	.....	1,650
48.	Tin	.....	2,270
49.	Tungsten	.....	5,900
50.	Zinc	.....	930

The Use of Round Numbers

Explanation:

In many cases where the use of exact numbers is not necessary, it is customary to express large amounts in round numbers. Round numbers may be expressed to the nearest hundred, thousand, ten thousand and so on, as required.

For example

Instead of saying \$180,306,599, we may state this amount to the nearest hundred thousand and call it \$180,300,000. \$306,000 was stated as \$300,000, because \$300,000 is nearer to being \$306,000 than is \$400,000 or \$200,000.

Integers

Addition, subtraction, multiplication and division of integers.

Exercise 2Addition

	1	2	3	4	5	6	7	8	9
a.	$\begin{array}{r} 1 \\ 7 \\ 5 \end{array}$	$\begin{array}{r} 4 \\ 3 \\ 6 \end{array}$	$\begin{array}{r} 6 \\ 4 \\ 1 \end{array}$	$\begin{array}{r} 7 \\ 5 \\ 3 \end{array}$	$\begin{array}{r} 5 \\ 4 \\ 1 \end{array}$	$\begin{array}{r} 8 \\ 3 \\ 2 \end{array}$	$\begin{array}{r} 7 \\ 4 \\ 1 \end{array}$	$\begin{array}{r} 8 \\ 7 \\ 3 \end{array}$	$\begin{array}{r} 8 \\ 5 \\ 4 \end{array}$
b.	$\begin{array}{r} 5 \\ 9 \\ 4 \end{array}$	$\begin{array}{r} 3 \\ 8 \\ 7 \end{array}$	$\begin{array}{r} 8 \\ 8 \\ 5 \end{array}$	$\begin{array}{r} 7 \\ 9 \\ 6 \end{array}$	$\begin{array}{r} 3 \\ 6 \\ 2 \end{array}$	$\begin{array}{r} 2 \\ 4 \\ 5 \end{array}$	$\begin{array}{r} 3 \\ 9 \\ 7 \end{array}$	$\begin{array}{r} 1 \\ 7 \\ 5 \end{array}$	$\begin{array}{r} 2 \\ 0 \\ 9 \end{array}$
c.	$\begin{array}{r} 5 \\ 9 \\ 7 \end{array}$	$\begin{array}{r} 9 \\ 4 \\ 7 \end{array}$	$\begin{array}{r} 3 \\ 0 \\ 8 \end{array}$	$\begin{array}{r} 1 \\ 9 \\ 6 \end{array}$	$\begin{array}{r} 4 \\ 3 \\ 7 \end{array}$	$\begin{array}{r} 6 \\ 8 \\ 7 \end{array}$	$\begin{array}{r} 5 \\ 4 \\ 7 \end{array}$	$\begin{array}{r} 8 \\ 3 \\ 4 \end{array}$	$\begin{array}{r} 7 \\ 9 \\ 3 \end{array}$
d.	$\begin{array}{r} 6 \\ 7 \\ 3 \end{array}$	$\begin{array}{r} 4 \\ 6 \\ 2 \end{array}$	$\begin{array}{r} 7 \\ 8 \\ 9 \end{array}$	$\begin{array}{r} 9 \\ 4 \\ 3 \end{array}$	$\begin{array}{r} 6 \\ 7 \\ 2 \end{array}$	$\begin{array}{r} 8 \\ 4 \\ 3 \end{array}$	$\begin{array}{r} 4 \\ 9 \\ 9 \end{array}$	$\begin{array}{r} 8 \\ 6 \\ 7 \end{array}$	$\begin{array}{r} 9 \\ 8 \\ 9 \end{array}$
e.	$\begin{array}{r} 7 \\ 4 \\ 6 \end{array}$	$\begin{array}{r} 8 \\ 9 \\ 9 \end{array}$	$\begin{array}{r} 9 \\ 6 \\ 7 \end{array}$	$\begin{array}{r} 8 \\ 7 \\ 6 \end{array}$	$\begin{array}{r} 4 \\ 7 \\ 9 \end{array}$	$\begin{array}{r} 6 \\ 8 \\ 2 \end{array}$	$\begin{array}{r} 9 \\ 8 \\ 1 \end{array}$	$\begin{array}{r} 1 \\ 9 \\ 6 \end{array}$	$\begin{array}{r} 8 \\ 7 \\ 6 \end{array}$

Subtraction

	1	2	3	4	5	6	7	8	9
a.	$\begin{array}{r} 39 \\ 8 \end{array}$	$\begin{array}{r} 91 \\ 6 \end{array}$	$\begin{array}{r} 46 \\ 4 \end{array}$	$\begin{array}{r} 75 \\ 7 \end{array}$	$\begin{array}{r} 29 \\ 7 \end{array}$	$\begin{array}{r} 43 \\ 8 \end{array}$	$\begin{array}{r} 24 \\ 5 \end{array}$	$\begin{array}{r} 36 \\ 7 \end{array}$	$\begin{array}{r} 45 \\ 9 \end{array}$
b.	$\begin{array}{r} 76 \\ 9 \end{array}$	$\begin{array}{r} 68 \\ 9 \end{array}$	$\begin{array}{r} 37 \\ 6 \end{array}$	$\begin{array}{r} 48 \\ 9 \end{array}$	$\begin{array}{r} 48 \\ 9 \end{array}$	$\begin{array}{r} 14 \\ 9 \end{array}$	$\begin{array}{r} 78 \\ 6 \end{array}$	$\begin{array}{r} 51 \\ 6 \end{array}$	$\begin{array}{r} 78 \\ 6 \end{array}$
c.	$\begin{array}{r} 39 \\ 8 \end{array}$	$\begin{array}{r} 27 \\ 3 \end{array}$	$\begin{array}{r} 41 \\ 4 \end{array}$	$\begin{array}{r} 32 \\ 7 \end{array}$	$\begin{array}{r} 48 \\ 6 \end{array}$	$\begin{array}{r} 92 \\ 8 \end{array}$	$\begin{array}{r} 67 \\ 9 \end{array}$	$\begin{array}{r} 69 \\ 5 \end{array}$	$\begin{array}{r} 15 \\ 6 \end{array}$

Subtraction (Continued)

	1	2	3	4	5	6	7	8	9
d.	$\begin{array}{r} 17 \\ 8 \end{array}$	$\begin{array}{r} 16 \\ 8 \end{array}$	$\begin{array}{r} 36 \\ 8 \end{array}$	$\begin{array}{r} 19 \\ 9 \end{array}$	$\begin{array}{r} 15 \\ 6 \end{array}$	$\begin{array}{r} 13 \\ 8 \end{array}$	$\begin{array}{r} 19 \\ 5 \end{array}$	$\begin{array}{r} 14 \\ 9 \end{array}$	$\begin{array}{r} 15 \\ 6 \end{array}$
e.	$\begin{array}{r} 72 \\ 5 \end{array}$	$\begin{array}{r} 78 \\ 9 \end{array}$	$\begin{array}{r} 67 \\ 8 \end{array}$	$\begin{array}{r} 87 \\ 6 \end{array}$	$\begin{array}{r} 72 \\ 9 \end{array}$	$\begin{array}{r} 82 \\ 3 \end{array}$	$\begin{array}{r} 71 \\ 9 \end{array}$	$\begin{array}{r} 65 \\ 7 \end{array}$	$\begin{array}{r} 65 \\ 3 \end{array}$

Multiplication

	1	2	3	4	5	6	7	8	9
a.	$\begin{array}{r} 74 \\ 5 \end{array}$	$\begin{array}{r} 37 \\ 4 \end{array}$	$\begin{array}{r} 36 \\ 3 \end{array}$	$\begin{array}{r} 48 \\ 2 \end{array}$	$\begin{array}{r} 27 \\ 9 \end{array}$	$\begin{array}{r} 46 \\ 6 \end{array}$	$\begin{array}{r} 52 \\ 7 \end{array}$	$\begin{array}{r} 74 \\ 8 \end{array}$	$\begin{array}{r} 38 \\ 9 \end{array}$
b.	$\begin{array}{r} 23 \\ 6 \end{array}$	$\begin{array}{r} 25 \\ 8 \end{array}$	$\begin{array}{r} 42 \\ 9 \end{array}$	$\begin{array}{r} 35 \\ 7 \end{array}$	$\begin{array}{r} 79 \\ 3 \end{array}$	$\begin{array}{r} 56 \\ 5 \end{array}$	$\begin{array}{r} 88 \\ 4 \end{array}$	$\begin{array}{r} 73 \\ 6 \end{array}$	$\begin{array}{r} 39 \\ 2 \end{array}$
c.	$\begin{array}{r} 87 \\ 3 \end{array}$	$\begin{array}{r} 67 \\ 3 \end{array}$	$\begin{array}{r} 37 \\ 4 \end{array}$	$\begin{array}{r} 42 \\ 6 \end{array}$	$\begin{array}{r} 84 \\ 6 \end{array}$	$\begin{array}{r} 16 \\ 7 \end{array}$	$\begin{array}{r} 29 \\ 6 \end{array}$	$\begin{array}{r} 84 \\ 7 \end{array}$	$\begin{array}{r} 36 \\ 7 \end{array}$
d.	$\begin{array}{r} 92 \\ 4 \end{array}$	$\begin{array}{r} 16 \\ 8 \end{array}$	$\begin{array}{r} 47 \\ 4 \end{array}$	$\begin{array}{r} 97 \\ 3 \end{array}$	$\begin{array}{r} 50 \\ 4 \end{array}$	$\begin{array}{r} 27 \\ 6 \end{array}$	$\begin{array}{r} 87 \\ 3 \end{array}$	$\begin{array}{r} 47 \\ 6 \end{array}$	$\begin{array}{r} 87 \\ 6 \end{array}$
e.	$\begin{array}{r} 47 \\ 7 \end{array}$	$\begin{array}{r} 38 \\ 6 \end{array}$	$\begin{array}{r} 29 \\ 3 \end{array}$	$\begin{array}{r} 47 \\ 6 \end{array}$	$\begin{array}{r} 87 \\ 3 \end{array}$	$\begin{array}{r} 92 \\ 6 \end{array}$	$\begin{array}{r} 99 \\ 9 \end{array}$	$\begin{array}{r} 29 \\ 6 \end{array}$	$\begin{array}{r} 87 \\ 9 \end{array}$

Division

	1	2	3	4	5	6	7	8	9
a.	$4 \overline{)32}$	$9 \overline{)54}$	$7 \overline{)84}$	$8 \overline{)56}$	$9 \overline{)72}$	$8 \overline{)32}$	$4 \overline{)48}$	$6 \overline{)66}$	$7 \overline{)63}$
b.	$\frac{40}{8}$	$\frac{30}{6}$	$\frac{66}{11}$	$\frac{14}{7}$	$\frac{96}{6}$	$\frac{36}{9}$	$\frac{63}{7}$	$\frac{64}{8}$	$\frac{49}{7}$

Division (Continued)

1 2 3 4 5 6 7 8 9

c. $5 \overline{)50}$ $8 \overline{)96}$ $8 \overline{)88}$ $2 \overline{)40}$ $5 \overline{)55}$ $7 \overline{)98}$ $4 \overline{)28}$ $5 \overline{)25}$ $3 \overline{)10}$

d. $\frac{36}{6}$ $\frac{18}{3}$ $\frac{55}{5}$ $\frac{45}{5}$ $\frac{63}{9}$ $\frac{81}{9}$ $\frac{63}{7}$ $\frac{36}{3}$ $\frac{72}{8}$

e. $\frac{90}{10}$ $\frac{56}{7}$ $\frac{8}{4}$ $\frac{81}{9}$ $\frac{49}{7}$ $\frac{33}{3}$ $\frac{40}{8}$ $\frac{28}{4}$ $\frac{15}{5}$

f. $\frac{99}{9}$ $\frac{49}{7}$ $\frac{45}{5}$ $\frac{63}{7}$ $\frac{96}{8}$ $\frac{72}{8}$ $\frac{48}{6}$ $\frac{84}{7}$ $\frac{12}{4}$

g. $6 \overline{)30}$ $8 \overline{)72}$ $9 \overline{)90}$ $6 \overline{)42}$ $7 \overline{)56}$ $9 \overline{)81}$ $8 \overline{)56}$ $5 \overline{)30}$ $8 \overline{)56}$

h. $6 \overline{)24}$ $4 \overline{)24}$ $9 \overline{)90}$ $8 \overline{)72}$ $6 \overline{)54}$ $4 \overline{)96}$ $7 \overline{)49}$ $8 \overline{)64}$ $4 \overline{)84}$

Chapter 111

SAVING TIME WHEN MAKING COMPUTATIONS

If you were asked to find the cost of four pounds of butter at twenty-five cents a pound, it would be absurd for you to make the computation on paper, because you can give the answer immediately by computing "in your head," as we sometimes say. Some people call this kind of computation mental arithmetic. By using mental arithmetic many problems are daily solved without paper or pencil.

You are already familiar with some of the short methods of computation in common use. A multiplication table is a short method. A knowledge of the tables enables you to make multiplications more quickly than you could obtain the results by addition.

In the lessons that follow you are to learn some new short methods of computation, and also how to apply them practically. Learn these thoroughly, and accustom yourself to working with them whenever you can save time by doing so. You will find that some of these short methods have been placed here for review. Even so, study them carefully and learn them well, for they will be of use to you throughout life.

When an amount is multiplied by 10 or a power of 10 (100; 1000; 10,000 etc.) the product is found by adding as many ciphers to the multiplicand as there are ciphers in the multiplier. Thus, $786 \times 10 = 7,860$. Of dollars and cents are involved, the two right hand figures in the product are cents, and the figures at the left of the cents are dollars. For example, $\$45.10 \times 100 = \$4,510.00$.

SHORT METHODS IN MULTIPLICATION

1. To multiply any number by 10 move the decimal point one place to the right, annexing a zero if necessary.

For example: $10 \times 84 = 840$. $10 \times 3.64 = 36.4$

11. To multiply any number by 100, move the decimal point two places to the right, annexing two zeros if necessary.

For example: $100 \times 32 = 3200$. $100 \times 3.784 = 378.4$

1111. To multiply any number by 1000, move the decimal point three places to the right, annexing three zeros if necessary.

For example: $1000 \times 74 = 74,000$. $1000 \times .3568 = 356.8$

SHORT METHODS IN MULTIPLICATION (Continued)

- IV. To multiply an integer by a number ending in zero, multiply the integer by the number or numbers to the left of the zero, and then annex a zero to this product.

For example: $325 \times 40 = ?$ First multiply 325 by 4. This gives 1300. Annex a zero to this number and obtains 13,000, the result.

- V. To multiply a number by 5, multiply by 10, then divide this result by 2.

For example: $5 \times 784 = \frac{7840}{2} = 3920.$

- VI. To multiply a number by 25, multiply by 100, then divide this result by 4.

For example: $25 \times 73 = \frac{7300}{4} = 1825.$

- VII. To multiply a number by 125, multiply by 1000, then divide this result by 8.

For example: $125 \times 67 = \frac{67000}{8} = 8375.$

- VIII. To multiply a number by 9, multiply by 10, then subtract the multiplicand.

For example: $9 \times 492 = 4920 - 492 = 4428.$

- IX. To multiply a number by $33\frac{1}{3}$, multiply by 100, then divide this result by 3.

For example: $33\frac{1}{3} \times 78 = \frac{7800}{3} = 2600.$

- X. To multiply a number by $66\frac{2}{3}$, multiply by 100, then take $\frac{2}{3}$ rds. of this result.

For example: $66\frac{2}{3} \times 36 = 3600 \times \frac{2}{3} = 2400.$

- XI. To multiply a number by $12\frac{1}{2}$, first multiply by 100, then divide this result by 8.

For example: $12\frac{1}{2} \times 48 = \frac{1}{8} \text{ of } 4800 = 600.$

Suggest a short method for multiplying a number by 50. By $16\frac{2}{3}$ by $37\frac{1}{2}$. By $62\frac{1}{2}$. By $87\frac{1}{2}$. Give three illustrations of each method you work out.

- XII. To multiply a number by 250, first multiply by 1000, then divide this result by 4.

For example: $250 \times 328 = \frac{1}{4} \text{ of } 328,000 = 82,000.$

Suggest a short method for multiplying a number by 500. By $333\frac{1}{3}$. By $666\frac{2}{3}$. By 750. Give three illustrations of each method you work out.

Exercise 3
(For Accuracy and Speed)

Without the use of paper or pencil, multiply each of the numbers in this exercise by 10, by 100, by 5, by 125.

	1	2	3	4	5	6	7	8	9
a.	19	24	16	8	18	32	48	6	30
b.	73	24	62	16	14	23	36	72	48
c.	92	67	464	144	368	72	44	22	17
d.	376	480	26.31	4.64	968	36.8	968	188	9656

Exercise 4
(For Accuracy and Speed)

Without the use of paper or pencil, multiply each of the numbers in this exercise by $33\frac{1}{3}$, by $66\frac{2}{3}$ and by 9.

	1	2	3	4	5	6	7	8	9
a.	33	27	69	45	21	84	99	39	93
b.	15	9	21	42	81	108	135	48	60
c.	54	66	90	78	120	144	180	36	168
d.	279	881	954	9846	1647	360	288	336	264

Exercise 5
(For Accuracy and Speed)

Multiply the numbers in column 1 by $12\frac{1}{2}$, those in column 2 by $16\frac{2}{3}$, etc., as designated.

	1	2	3	4	5
	$12\frac{1}{2}$	$16\frac{2}{3}$	250	25	$33\frac{1}{3}$
	x	x	x	x	x
a.	464	360	78	480	729
b.	384	612	420	388	468
c.	9672	486	364	204	324
d.	4800	354	792	760	864
e.	32.08	270	4.4	79232	936
f.	4240	42.6	980	49.6	522

You have probably discovered that $37\frac{1}{2}$ is $\frac{3}{8}$ of 100; that $62\frac{1}{2}$ is $\frac{5}{8}$ of 100; and that $87\frac{1}{2}$ is $\frac{7}{8}$ of 100.

A table showing these relationships might be expressed in this way:

	10	100	1000
$\frac{1}{8} - -$	$1\frac{1}{4}$	$12\frac{1}{2}$	125
$\frac{1}{6} - -$		$16\frac{2}{3}$	$166\frac{2}{3}$
$\frac{1}{4} - -$	$2\frac{1}{2}$	25	250
$\frac{1}{2} - -$	5	50	500

Since $\frac{1}{8}$ of 100 is $12\frac{1}{2}$

$\frac{3}{8}$ is $3 \times 12\frac{1}{2} = 37\frac{1}{2}$

SHORT METHODS IN ADDITION

Method used in adding two numbers

For example:

$$46 + 32 = ?$$

$$\text{Think: } 46 + 30 = 76 \quad 76 + 2 = 78$$

Another example, which shows a simple way to add three figure numbers that end in zero:

$$\$4.20 + \$3.90 = ?$$

$$\text{Think: } \$4.20 + \$3.00 = \$7.20$$

$$\$7.20 + \$0.90 = \$8.10$$

Exercise 6
(For Accuracy and Speed)

Addition

	1	2	3	4	5
a.	<u>36</u> 27	<u>49</u> 88	<u>32</u> 74	<u>93</u> 72	<u>28</u> 16
b.	<u>41</u> 75	<u>69</u> 13	<u>75</u> 22	<u>96</u> 23	<u>41</u> 75
c.	<u>63</u> 52	<u>15</u> 63	<u>14</u> 33	<u>21</u> 66	<u>23</u> 82
d.	<u>74</u> 54	<u>14</u> 19	<u>65</u> 24	<u>56</u> 62	<u>21</u> 34
e.	<u>39</u> 95	<u>43</u> 28	<u>42</u> 12	<u>32</u> 68	<u>73</u> 15
f.	<u>12</u> 48	<u>65</u> 23	<u>24</u> 82	<u>16</u> 12	<u>74</u> 12
g.	<u>89</u> 31	<u>25</u> 54	<u>32</u> 47	<u>85</u> 55	<u>21</u> 34

Method used in adding more than two numbers.

In many cases when you wish to verify the accuracy of your answer, you should do it rapidly by mental addition. In adding columns of figures you can increase your speed by mentally combining two or more figures and adding them to the others in one amount. Figures that amount to 10 when combined are recognized most easily.

$$\begin{array}{r}
 10 \quad \left(\begin{array}{c} 85 \\ 25 \end{array} \right) \quad 10 \\
 12 \quad \left(\begin{array}{c} 96 \\ 34 \end{array} \right) \quad 10 \\
 15 \quad \left(\begin{array}{c} 84 \\ 73 \end{array} \right) \quad 7 \\
 13 \quad \left(\begin{array}{c} 36 \\ 74 \end{array} \right) \quad 10 \\
 \hline
 507
 \end{array}$$

The method of combining the figures in each column is shown in the illustration at the left. The two figures are combined by brackets and the sum is indicated at the right or the left of the brackets. The mental process when the first column is added should be "10, 17, 27, 37". The 7 is written and the 3 is carried to be included in the first group in the second column. The process in the second column is "13, 28, 40, 50".

Exercise 7 (For Accuracy and Speed)

Add the columns in the following problems. So far as possible add two figures at a time. Practice on the problems until you can add them quickly and accurately.

	1	2	3	4	5
a.	16 92 85 63	46 83 37 83	36 14 93 17	47 23 72 38	36 74 75 67
b.	24 56 38 72	38 72 75 35	63 47 57 68	14 26 78 46	23 87 68 97
c.	37 51 42 14	33 72 28 34	15 63 14 33	42 12 32 68	12 34 33 48
d.	69 13 75 22	31 45 29 44	31 82 34 44	95 24 12 74	89 31 25 54

Exercise 7 (Continued)

	1	2	3	4	5
e.	<div style="text-align: right;"> 44 97 41 32 </div>	<div style="text-align: right;"> 24 82 16 12 </div>	<div style="text-align: right;"> 41 75 63 52 </div>	<div style="text-align: right;"> 42 25 51 34 </div>	<div style="text-align: right;"> 31 96 43 28 </div>
f.	<div style="text-align: right;"> 23 82 74 54 </div>	<div style="text-align: right;"> 22 86 14 19 </div>	<div style="text-align: right;"> 12 48 65 23 </div>	<div style="text-align: right;"> 24 59 33 24 </div>	<div style="text-align: right;"> 13 98 56 32 </div>
g.	<div style="text-align: right;"> 14 33 21 66 </div>	<div style="text-align: right;"> 32 68 73 15 </div>	<div style="text-align: right;"> 33 48 66 32 </div>	<div style="text-align: right;"> 16 12 74 12 </div>	<div style="text-align: right;"> 41 32 45 52 </div>

SHORT METHODS IN DIVISION

Short methods in division can be used in some cases. The method is based on the same principle as shown in the short methods in multiplication.

- I. To divide by 10, move the decimal point one place to the left, prefixing a zero if necessary.

For example: $794 \div 10 = 79.4$ $.378 \div 10 = .0378$.

- II. To divide by 100, move the decimal point two places to the left, prefixing two zeros if necessary.

For example: $3840 \div 100 = 38.4$ $.437 \div 100 = .00437$.

- III. To divide by 1000, move the decimal point three places to the left, prefixing three zeros if necessary.

For example: $42,760 \div 1000 = 42.76$ $37 \div 1000 = .037$.

- IV. To divide by 5, multiply by 2 and divide by 10.

For example: $785 \div 5$ $785 \times 2 = 1570$ $1570 \div 10 = 157$.

- V. To divide by 25, multiply by 4 and divide by 100.

For example: $475 \div 25$ $475 \times 4 = 1900$ $1900 \div 100 = 19$.

- VI. To divide by 125, multiply by 8, and divide by 1000.
For example: $1750 \div 125$ $1750 \times 8 = 14,000$ $14,000 \div 1000 = 14$
- VII. To divide by $12\frac{1}{2}$, multiply by 8 and divide by 100.
For example: $225 \div 12\frac{1}{2}$ $225 \times 8 = 1800$ $1800 \div 100 = 18$.
- VIII. To divide by $33\frac{1}{3}$, multiply by 3 and divide by 100.
For example: $800 \div 33\frac{1}{3}$. $800 \times 3 = 2400$ $2400 \div 100 = 24$.
- IX. To divide by $16\frac{2}{3}$, multiply by 6 and divide by 100.
For example: $250 \div 16\frac{2}{3}$ $250 \times 6 = 1500$ $1500 \div 100 = 15$.
- X. To divide by $66\frac{2}{3}$, multiply by 3 and divide by 200.
For example: $1200 \div 66\frac{2}{3}$ $1200 \times 3 = 3600$ $3600 \div 200 = 18$.

Exercise 8
(For Accuracy and Speed)

Do the following divisions without pencil or paper:

- | | 1 | 2 | 3 | 4 |
|----|--------------------------|--------------------------|-------------------------|--------------------------|
| a. | $48 \div 33\frac{1}{3}$ | $850 \div 25$ | $95 \div 25$ | $475 \div 25$ |
| b. | $72 \div 12\frac{1}{2}$ | $340 \div 66\frac{2}{3}$ | $38 \div 125$ | $780 \div 12\frac{1}{2}$ |
| c. | $375 \div 125$ | $42 \div 16\frac{2}{3}$ | $48 \div 12\frac{1}{2}$ | $35 \div 16\frac{2}{3}$ |
| d. | $360 \div 12\frac{1}{2}$ | $72 \div 25$ | $90 \div 66\frac{2}{3}$ | $96 \div 25$ |
| e. | $640 \div 12\frac{1}{2}$ | $320 \div 6\frac{1}{4}$ | $96 \div 33\frac{1}{3}$ | $48 \div 25$ |
| f. | $420 \div 16\frac{2}{3}$ | $640 \div 12\frac{1}{2}$ | $65 \div 250$ | $500 \div 12\frac{1}{2}$ |

Exercise 9

Home Work

1. At $\$.16\frac{2}{3}$ a yard, how many yards of cloth can be bought for \$1.50? For \$8.00?
2. An agent sold a farm for \$20,000, at the rate of \$125 an acre. How many acres did he sell?
3. At \$.25 a yard, how many yards of cloth can be bought for \$7.25? For \$37.50? For \$18.75? For \$72.25?
4. At $$.33\frac{1}{3}$ a dozen, how many eggs can be bought for \$7.00? For \$52.00? For \$75.00?
5. At $$.66\frac{2}{3}$ a gross, how many gross of pens can be bought for \$12.00? For \$18.00?
6. At the price of $$.12\frac{1}{2}$ a yard, how many yards of gingham can you buy for \$3.00? For \$7.00? For \$11.00? For \$8.00?
7. A new clerk finds that calico sells at $8\frac{1}{3}$ cents a yard. He wants to work out a short method to use when finding how many yards of this calico are to be sold for a certain number of dollars. Can you suggest a method?

Chapter IV

COMMON FRACTIONS AND DECIMALS

BUDGETS

Budgeting simply means estimating in advance what you are going to spend of the income you receive. Budgeting means that you plan to set aside a certain part for necessities, savings, recreation, etc. It is one of the first steps in the wise administration of personal finances: Income is not the only thing budgeted. Time is being budgeted more frequently now than in the past. The chart at the left pictures the distribution of a soldier's time at this Special Service School. It shows how the 24 hours of a single day are used.

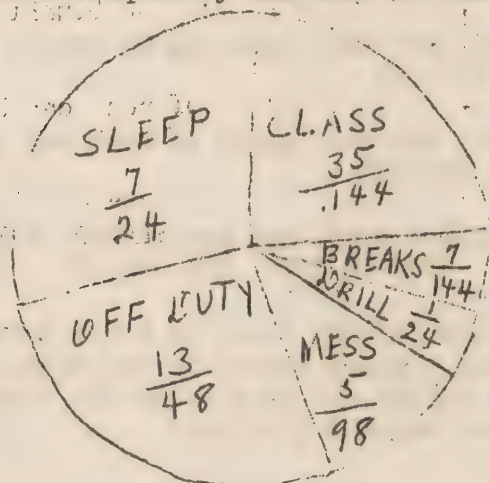


Fig. 1.

BUDGET OF A STUDENT'S DAY

The whole 24 hours of a day is spoken of as a unit. A part of any unit is called a fraction. Thus, the fractions of the 24 hour day are: $\frac{7}{24}$; $\frac{35}{144}$; $\frac{7}{144}$; $\frac{1}{24}$; $\frac{5}{98}$, $\frac{13}{48}$.

An hour is a unit. We speak of $\frac{1}{2}$ an hour, $\frac{1}{4}$ of an hour.

A pound is a unit. Think of $\frac{1}{4}$, $\frac{1}{8}$, $\frac{3}{4}$, of a pound.

The earth is a unit. We read that about $\frac{1}{3}$ of the area of the earth is land and about $\frac{2}{3}$ is water.

Anything is a unit as a matter of fact. We may speak of part of a crowd, half a regiment, a tenth of a class, a twentieth of the population. To use such terms with exactness it would be of course necessary to know the accurate number of individuals in a crowd, regiment, class, or population.

Terms used in speaking of fractions.

$\frac{3}{4}$ numerator
 denominator

$\frac{3}{4}$ is called a fraction.

The denominator tells you the number of equal parts into which the unit has been divided.

The numerator tells you how many of these equal parts are taken to form the fraction. Numerator means numberer.

Proper fraction. When the numerator is less than the denominator, the fraction is called a proper fraction. This definition may seem difficult to understand, so think of a proper fraction as a part of a unit.

Improper fraction. When the numerator is greater than the denominator, the fraction is called an improper fraction. In other words an improper fraction is larger than a unit.

For example:

$\frac{7}{4}$, $\frac{9}{3}$, $\frac{14}{4}$, $\frac{7}{7}$.

Exercise 10

(Do on Black Board)

1. Draw a line and divide it into 12 equal parts. What is each part called? Point out $\frac{6}{12}$ of the line. $\frac{8}{12}$ of the line.
2. Draw a circle, then divide it into 8 equal parts. Point out $\frac{5}{8}$ of the circle. $\frac{3}{8}$ of the circle.
3. Draw a line and show $\frac{1}{2}$ of it. $\frac{3}{4}$ of it. $\frac{5}{8}$ of it.
4. Write five proper fractions and tell what the numerator and denominator of each indicates.
5. Which of the following fractions indicates the greatest, and which the least value: $\frac{1}{3}$ $\frac{1}{2}$ $\frac{1}{4}$ $\frac{1}{5}$? By properly marking off four lines of equal length, show that your answer is correct.
6. Arrange the following fractions in the order of their value. placing the largest first: $\frac{2}{5}$ $\frac{2}{3}$ $\frac{2}{15}$ $\frac{2}{8}$ $\frac{2}{6}$.
7. Arrange the following fractions in the order of their value, placing the smallest first: $\frac{3}{12}$ $\frac{7}{12}$ $\frac{5}{12}$ $\frac{9}{12}$ $\frac{8}{12}$ $\frac{1}{12}$.
8. If I write two fractions with equal numerators but unequal denominators, how can you tell at once which fraction has the greater value? Give examples.
9. If I write two fractions with equal denominators but unequal numerators, how can you tell at once which has the greater value? Give examples.
10. Write three fractions, each having 5 for a numerator, and each having a value less than $\frac{5}{8}$.

11. Write three fractions, each having 6 for a denominator, and each having a value greater than $2/6$.

12. Write three fractions, each of which is greater in value than $5/12$ and less in value than $5/8$.

13. Into how many equal parts is the line in Fig. 2 divided? What is each part called?



Fig. 2

HOW TO REDUCE A FRACTION TO ITS LOWEST TERMS

Observe the line shown in Fig. 2, and compare $2/3$ of it with $8/12$ of it.

What is the result if you divide both terms of the fraction $8/12$ by 4?

Draw a line and divide it into 10 equal parts. Compare the length of $5/10$ of the line with $1/2$ of it.

What is the result if you divide both terms of the fraction $5/10$ by 5?

Draw two lines of equal length. Divide one of them into 4 equal parts, the other into 8 equal parts. How does the length of $3/4$ of one line compare with $6/8$ of the other?

What is the result if you multiply both terms of the fraction $3/4$ by 2?

The exercises above should call your attention to the following very important fact:

Multiplying or dividing both terms of a fraction by the same number does not change the value of the fraction.

One				A
$1/2$		$1/2$		B
$1/4$	$1/4$	$1/4$	$1/4$	C
$1/8$	$1/8$	$1/8$	$1/8$	D

Fig. 3

For example, let us multiply $1/2$ by 2

$$1/2 \times 2 = \frac{2 \times 1}{2 \times 2} = \frac{2}{4} \text{ or two } \frac{1}{4} \text{ ths.}$$

Look at C in Fig. 3.

For example, let us divide $2/4$ by 2.

$$\frac{2}{4} \div 2 = 2 \overline{) 2/4} = 1/2$$

We can do another problem to prove to ourselves this fact. When we multiply $2/4$ by 2, we get $4/8$. Look at Fig. 3. Are two $1/4$ ths equal to four $1/8$ ths. If we divide $4/8$ by 2, we get two $1/4$ ths. This problem can be proved by referring to Figure 3. Of course, this manner of proving may be objected to as insufficient. If so, you could prove the fact, by showing that actual measurement the $1/4$ th rectangle is equal to two $1/8$ ths.

Reduction to lowest terms. When the numerator and denominator of a fraction are divided by the same number, the fraction is said to be reduced to lower terms.

For example: (Look at Fig. 3, D and C)

$$6/8 \text{ divided by } 2 = 2 \overline{) 6/8} = 3/4$$

$$8/12 \text{ divided by } 4 = 2/3$$

$$10/12 \text{ divided by } 2 = 5/6$$

$$3/9 \text{ divided by } 3 = 1/3$$

Raising to higher terms. When both the numerator and denominator of a fraction are multiplied by the same number, the fraction is said to be raised to higher terms.

For example: (Look at Fig. B and D).

$$1/2 \times 4 = \frac{4 \times 1}{4 \times 2} = 4/8.$$

$1/2$ is equal (in size) to four $1/8$ ths.

$$2/3 \text{ multiplied by } 5 = 10/15$$

EXERCISE 11

1. Tell which of the following fractions are not in lowest terms. Change them to lowest terms.

$$\frac{3}{4} \quad \frac{2}{3} \quad \frac{5}{10} \quad \frac{7}{8} \quad \frac{12}{15} \quad \frac{8}{12} \quad \frac{9}{15} \quad \frac{6}{10} \quad \frac{16}{32}$$

2. Change each of the following fractions to lowest terms.

$$\frac{4}{16} \quad \frac{6}{32} \quad \frac{8}{24} \quad \frac{20}{25} \quad \frac{3}{15} \quad \frac{12}{16} \quad \frac{15}{25}$$

3. Change each of the following fractions to 12ths.
To 24ths.

$$\frac{1}{3} \quad \frac{1}{6} \quad \frac{1}{4} \quad \frac{2}{3} \quad \frac{5}{2} \quad \frac{3}{4} \quad \frac{7}{3} \quad \frac{1}{2} \quad \frac{5}{3}$$

4. Change each of the following fractions to 20ths.

$$\frac{1}{2} \quad \frac{1}{4} \quad \frac{1}{5} \quad \frac{3}{10} \quad \frac{3}{4} \quad \frac{4}{5} \quad \frac{7}{10} \quad \frac{3}{5} \quad \frac{9}{10} \quad \frac{7}{5}$$

5. Write in lowest terms a fraction which equals each of the following:

$$\frac{12}{16} \quad \frac{8}{24} \quad \frac{30}{50} \quad \frac{25}{75} \quad \frac{14}{70} \quad \frac{32}{64} \quad \frac{12}{32} \quad \frac{15}{12}$$

Similar Fractions.

Fractions that have a common denominator are called like fractions or similar fractions. In other words those fractions whose denominators are the same are thought of as having something in common, namely the denominators.

For example.

$$\frac{1}{4} \text{ and } \frac{3}{4} \text{ are similar fractions.}$$

Least Common Denominator

You can make unlike fractions similar by finding the least common denominator; that is, the smallest number that is common to both.

For example.

$$\frac{2}{3}, \quad \frac{3}{4}, \quad \frac{5}{6}. \quad \text{Find the least common denominator.}$$

You ask yourself, "What is a number into which 3, 4, and 6 will go evenly?" By trial and error, you discover that 12 is such a number. So are 24, 36, 48 and many more. We speak of 12 as the least common denominator, since 12 is the smallest (least) of 12, 24, 36, 48.

Once you find the least common denominator you are ready to reduce these fractions to twelfths.

$$\frac{2}{3} = \frac{?}{12}$$

$$\frac{3}{4} = \frac{?}{12}$$

$$\frac{5}{6} = \frac{?}{12}$$

PROBLEM. Turn to Figure 1, Page 16, and find the least common denominator of the fractions shown in Figure 1.

Mixed Number.

A number that consists of an integer and a fraction is called a mixed number.

For example:

5-1/3 is a mixture of an integer and a fraction.

Reducing mixed numbers to improper fractions.

How can 5-1/3 be reduced to an improper fraction?

Solution in detail

$$1 = \frac{3}{3}$$

$$5 = \frac{15}{3}$$

$$\frac{15}{3} + \frac{1}{3} = \frac{16}{3}$$

Quick Solution

$$5\frac{1}{3} =$$

$$\frac{5 \times 3 + 1}{3} = \frac{16}{3}$$

EXERCISE 12

1. Reduce the following to improper fractions.

a.	b.	c.	d.	e.
1. $2\frac{1}{2}$	$3\frac{1}{3}$	$5\frac{1}{2}$	$4\frac{2}{3}$	$12\frac{1}{2}$
2. $66\frac{2}{3}$	$62\frac{1}{2}$	$9\frac{1}{5}$	$5\frac{7}{8}$	$16\frac{2}{3}$
3. $6\frac{1}{4}$	$37\frac{1}{2}$	$33\frac{1}{3}$	$7\frac{2}{5}$	$8\frac{3}{4}$
4. $7\frac{1}{4}$	$9\frac{2}{3}$	$10\frac{2}{5}$	$6\frac{8}{9}$	$4\frac{3}{4}$
5. $9\frac{1}{8}$	$49\frac{10}{10}$	$16\frac{1}{3}$	$20\frac{2}{5}$	$19\frac{3}{4}$
6. $100\frac{1}{3}$	$96\frac{2}{3}$	$50\frac{1}{4}$	$61\frac{2}{3}$	$18\frac{1}{6}$
7. $68\frac{1}{9}$	$72\frac{1}{3}$	$41\frac{1}{2}$	$36\frac{1}{3}$	$13\frac{2}{3}$
8. $41\frac{2}{5}$	$16\frac{1}{8}$	$12\frac{1}{2}$	$13\frac{1}{4}$	$16\frac{1}{7}$
9. $13\frac{2}{3}$	$16\frac{1}{5}$	$14\frac{1}{2}$	$10\frac{1}{10}$	$4\frac{8}{9}$
10. $4\frac{7}{8}$	$3\frac{9}{11}$	$6\frac{4}{20}$	$8\frac{3}{25}$	$8\frac{1}{4}$

EXERCISE 13

1. Reduce the following to integers or mixed numbers.

a.	b.	c.	d.	e.
1. $\frac{5}{3}$	$\frac{5}{4}$	$\frac{6}{3}$	$\frac{8}{2}$	$\frac{9}{4}$
2. $\frac{24}{8}$	$\frac{14}{3}$	$\frac{20}{5}$	$\frac{18}{8}$	$\frac{48}{12}$
3. $\frac{32}{10}$	$\frac{13}{5}$	$\frac{20}{4}$	$\frac{18}{15}$	$\frac{37}{3}$
4. $\frac{47}{5}$	$\frac{18}{3}$	$\frac{16}{4}$	$\frac{14}{3}$	$\frac{12}{5}$
5. $\frac{16}{3}$	$\frac{17}{5}$	$\frac{14}{4}$	$\frac{13}{8}$	$\frac{16}{5}$
6. $\frac{30}{4}$	$\frac{50}{4}$	$\frac{100}{8}$	$\frac{96}{8}$	$\frac{78}{9}$
7. $\frac{200}{10}$	$\frac{450}{45}$	$\frac{130}{10}$	$\frac{146}{12}$	$\frac{108}{8}$
8. $\frac{94}{4}$	$\frac{87}{6}$	$\frac{92}{8}$	$\frac{49}{6}$	$\frac{74}{10}$
9. $\frac{65}{6}$	$\frac{39}{6}$	$\frac{46}{9}$	$\frac{54}{8}$	$\frac{37}{6}$
10. $\frac{16}{3}$	$\frac{28}{7}$	$\frac{91}{10}$	$\frac{810}{8}$	$\frac{67}{9}$

You have now studied many new terms. Be sure you understand them. Study them again if necessary.

Budgets

Denominator

Numerator

Proper fraction

Improper fraction

Reduction to lowest terms

Raising to higher terms

Similar fractions

Least common denominator

Mixed numbers

ADDITION AND SUBTRACTION OF FRACTIONS

Two fractions may be added or subtracted by first expressing them with the same denominator, then adding or subtracting their numerators, as the case requires.

EXERCISE 14

- | | 1 | 2 | 3 | 4 |
|----|-----------------------------------------------|-----------------|----------------|---------------|
| a. | $1/2 + 1/3$ | $1/9 + 1/10$ | $4/5 + 1/6$ | $3/4 + 1/3$ |
| b. | $1/5 + 1/6$ | $1/8 + 1/10$ | $5/6 + 7/8$ | $2/3 + 3/4$ |
| c. | $1/5 + 1/8$ | $1/8 - 1/6$ | $3/7 + 1/4$ | $3/5 + 2/7$ |
| d. | $1/4 + 1/7$ | $1/4 + 1/3$ | $2/5 + 1/3$ | $5/6 + 7/8$ |
| e. | $1/6 + 1/5$ | $1/3 + 3/4$ | $1/4 + 3/8$ | $4/9 + 3/10$ |
| f. | $1/4 + 1/8$ | $2/5 + 1/6$ | $1/7 + 3/6$ | $2/15 + 3/5$ |
| g. | $1/7 + 1/3$ | $3/8 + 1/6$ | $3/4 + 5/8$ | $3/4 + 3/20$ |
| h. | $9/14 + 17/28$ | $11/17 + 8/34$ | $11/15 - 3/5$ | $6/8 - 1/3$ |
| i. | $13/15 + 13/20$ | $5/72 + 53/56$ | $10/11 - 3/22$ | $7/20 - 1/4$ |
| j. | $7/24 + 19/36$ | $31/32 + 49/96$ | $3/4 - 1/2$ | $3/8 - 1/4$ |
| k. | $25/36 + 19/48$ | $43/48 + 35/36$ | $2/3 - 1/6$ | $3/8 - 1/16$ |
| l. | $11/17 + 8/34$ | $16/25 + 3/50$ | $6/7 - 1/9$ | $3/16 - 2/48$ |
| m. | $22/27 - 2/9$ | $7/16 - 3/64$ | $23/28 - 5/14$ | $16/30 + 6/7$ |
| n. | $9/10 + 3/4$ | $1/10 + 1/100$ | $1/3 + 2/3$ | $6/9 + 9/18$ |
| o. | Add the fractions shown in Figure 1, Page 16. | | | |

EXERCISE 15

Add the following:

	a.	b.	c.	d.
a.	$3-2/3$ $4-1/4$ <u>$5-1/8$</u>	$3/5$ $2/3$ <u>$2/5$</u>	$4/5$ $3/4$ <u>$3/20$</u>	$1/4$ $1/3$ <u>$5/6$</u>
b.	$7/8$ $3/4$ <u>$1/2$</u>	$3/4$ $2/3$ <u>$5/12$</u>	$7/8$ $3/16$ <u>$7/32$</u>	$3/4$ $2/3$ <u>$6/24$</u>
c.	$3-7/8$ $4-3/4$ $9-1/2$ <u>$8-3/8$</u>	$5-3/16$ $4-5/8$ $7-1/2$ <u>$6-1/4$</u>	$9-3/4$ $5-2/3$ $3-5/6$ <u>$4-7/12$</u>	$5-3/4$ $9-5/6$ $7-2/3$ <u>$8-1/12$</u>
d.	$5-7/10$ $8-2/5$ <u>$4-2/15$</u>	$4-2/3$ $7-1/2$ <u>$6-5/6$</u>	$6-1/9$ $2-3/18$ <u>$4-1/3$</u>	$7-3/16$ $4-2/8$ <u>$7-5/8$</u>

MULTIPLICATION OF FRACTIONS

In working with fractions, it is frequently necessary to multiply a fraction by a fraction. For example in Figure 1, Page 16, it is shown that $5/48$ of the day (24 hours) is apportioned to mess.

$5/48$ represents $2-1/2$ hours. As a rule you spent about $1-1/4$ hours a day in the mess. Since $1-1/4$ is one half of $2-1/2$, you spent $1/2$ of $5/48$ of a day. How do you find what $1/2$ of $5/48$ is?

$5/48 \times 1/2 = 5/96$. The answer $5/96$ is obtained by multiplying the numerators to find the numerator of the product, and the denominators are multiplied to find the denominator of the product.

In the example above $5/96$ is already in the lowest term, as no number can be divided into both numerator and denominator.

Terms

OF. In the example $1/2$ of $5/48$, note that this means

$$1/2 \times 5/48$$

Cancellation

When in two or more fractions to be multiplied, there are factors common to the numerators and the denominators, cancellation of these factors may be made before multiplying. Cancellation does not change the value of the product.

$$\frac{5}{6} \text{ of } \frac{12}{35} \text{ of } \frac{7}{9} = \frac{\cancel{5}}{6} \times \frac{\overset{2}{\cancel{12}}}{\underset{\cancel{7}}{35}} \times \frac{\cancel{7}}{9} = \frac{2}{9}$$

The numerator 5 of the first fraction, $5/6$, is a factor of 35, the denominator of the second fraction; Therefore the 5's are eliminated by division, leaving 7 as the denominator of the second fraction. The 7 is then cancelled against the numerator of the third fraction, $7/9$. As 6, the denominator of the first fraction, is a factor of 12, the numerator of the second fraction, the 6's are also eliminated, leaving 2 as the numerator of the second fraction. The product, therefore, is $2/9$ as 2 is the only numerator, and 9 the only denominator left. If there were two or more numerators left, these would be multiplied to obtain the numerator of the product. The same process would apply in the case of two or more denominators.

Proof $\frac{5}{6} \times \frac{12}{35} \times \frac{7}{9} = \frac{5 \times 12 \times 7}{6 \times 35 \times 9} = \frac{420}{1890}$

$$= \frac{2}{9}$$

EXERCISE 16

Do the following multiplications of fractions. Make use of cancellation where it is possible.

	1	2	3	4	5
a.	$5 \times 2/3$	$3/4 \times 7/8$	$5/8 \times 12/25$	$4/9 \times 3/4$	$15/3 \times 3$
b.	$4 \times 5/6$	$2/3 \times 7/16$	$3/4 \times 12/15$	$16/35 \times 27/36$	$20/4 \times 8/5$
c.	$3/5 \times 10$	$4/5 \times 5/8$	$5/8 \times 24$	$27/50 \times 20/63$	$8/9 \times 5/8$
d.	$2/3 \times 3/8$	$5/8 \times 14/15$	$1/2 \times 4/9$	$36 \times 19/24$	$48 \times 35/24$
e.	$4/5 \text{ of } 5/4$	$5/6 \times 66$	$1/3 \times 9/2$	$3 \times 4/9$	$8 \times 3/4$
f.	$5/6 \text{ of } 7/10$	$1/6 \times 1/5$	$8/9 \times 5/8$	$2/3 \times 18/4$	$6 \times 2/3$
g.	$3/8 \times 2/5$	$3/4 \times 7/8$	$1/2 \times 4/9$	$6/7 \times 14/2$	$35/86 \times 27/43$
h.	$3/4 \times 5/8$	$1/5 \times 3/4$	$8/9 \times 3/5$	$1/2 \text{ of } 1/3$	$63/64 \times 65/72$
i.	$7/8 \times 2/3$	$1/3 \times 12$	$24/29 \times 37/38$	$1/3 \text{ of } 1/6$	$27/56 \times 64/81$
j.	$3/5 \times 5/6$	$2/5 \times 7/8$	$45/64 \times 56/63$	$1/8 \text{ of } 1/4$	$72/91 \times 53/64$

DIVISION OF FRACTIONS

At times it is necessary to divide one fraction by another. For example, suppose you want to know how many quarters there are in \$7.50. In other words, you wish to find out how many times $1/4$ of a dollar goes into $7-1/2$ dollars.

$$7-1/2 \div 1/4 = 15/2 \div 1/4$$

$$= 30/4 \div 1/4 \quad \dots \text{the denominators are now the same, and can therefore be discarded, the problem becoming}$$

$$= 30 \div 1 = 30$$

Also, the problem may be solved if the division fraction is inverted and the two fractions multiplied. This method is easier if the fractions do not already have a common denominator. Fundamentally this method is the same as that explained above but it makes unnecessary the finding of the common denominator.

For example:

$$\begin{aligned} 7-1/2 \div 1/4 &= 15/2 \div 1/4 = 15/2 \times 4/1 \\ &= 60/2 \\ &= 30 \end{aligned}$$

compare with the following:

$$\begin{aligned} 7-1/2 \div 1/4 &= 15/2 \div 1/4 \\ &= \frac{15 \times 2}{2 \times 2} \div 1/4 \\ &= (15 \times 2) \div (1) \\ &= 30/1 \\ &= 30 \end{aligned}$$

EXERCISE 17

Divide the following fractions:

1	2	3	4	5
a. $1/2 \div 1/4$	$8/25 \div 2/5$	$18/36 \div 6/18$	$8/21 \div 4/5$	$4/3 \div 3/8$
b. $1/4 \div 1/2$	$9/26 \div 3/2$	$22/34 \div 11/17$	$1/3 \div 9/8$	$5/16 \div 7/8$
c. $3/4 \div 3/4$	$14/39 \div 7/3$	$27/45 \div 9/15$	$4/5 \div 2/3$	$40 \div 1/8$
d. $4/9 \div 2/3$	$6/15 \div 2/3$	$18/34 \div 9/17$	$6/9 \div 2/3$	$16 \div 1/9$
e. $2/3 \div 1/6$	$4/10 \div 4/5$	$13/60 \div 13/15$	$4/7 \div 21/8$	$1/8 \div 60$
f. $5/8 \div 2/3$	$7/22 \div 7/2$	$18/75 \div 9/25$	$3/8 \div 16/4$	$1/3 \div 21$
g. $1/5 \div 1/2$	$6/32 \div 1/2$	$27/90 \div 9/30$	$1/3 \div 6/15$	$100 \div 1/5$
h. $1/5 \div 1/4$	$1/7 \div 7/8$	$55/66 \div 5/11$	$15/4 \div 4/9$	$1/5 \div 1/100$
i. $5/12 \div 5/8$	$1/8 \div 3/5$	$4/10 \div 4/5$	$32/3 \div 6/12$	$7/9 \div 4/9$
j. $9/21 \div 2/7$	$1/5 \div 1/2$	$6/15 \div 2/3$	$7/8 \div 8/7$	$1/25 \div 30$

FRACTIONAL RELATIONSHIP BETWEEN NUMBERS

Frequently it is desired to show the fractional relationship of one number to another. In other words, what is the fractional relationship of one hour to 24 hours? This is expressed as $1/24$. Thus 1 hour is $1/24$ of 24 hours.

What is the relationship of \$10 to \$40? It is expressed as $10/40 = 1/4$.

The mental process of solution applied to problem number one (below) would be: 2 is $1/20$ of 40 because the fraction $2/40$ reduced to its lowest terms is $1/20$.

In a like manner 4 is $1/10$ of 40 because $4/40$ reduced to its lowest terms is $1/10$.

EXERCISE 18

What fractional part of:

1. 40 is 2; 4; 8; 10; 20 ?
2. 24 is 2; 3; 6; 4; 8; 12 ?
3. 72 is 2; 3; 4; 6; 8; 9; 12; 18; 24; 36 ?
4. 48 is 2; 3; 4; 6; 8; 12; 24 ?
5. 52 is 2; 5; 10; 25 ?
6. 56 is 2; 4; 7; 8; 14; 28 ?
7. 80 is 2; 4; 5; 8; 10; 16; 20; 40 ?
8. 63 is 3; 7; 9; 21 ?

Example

If 40 miles per hour is $2/5$ of the speed of a train, the speed of the train may be calculated as follows:

If $2/5$ of the speed is 40 miles per hour, then $1/5$ of 40 is $40 \div 2$, or 20 miles per hour.

If $1/5$ of the speed is 20 miles per hour, then $5/5$ is 5×20 or 100 miles per hour.

EXERCISE 19

- | | 1 | 2 | 3 |
|----|---------------------------|---------------------------|----------------------------|
| a. | 27 is $\frac{3}{4}$ of? | 26 is $\frac{13}{14}$ of? | 18 is $\frac{3}{4}$ of? |
| b. | 15 is $\frac{3}{5}$ of? | 14 is $\frac{7}{8}$ of ? | 20 is $\frac{10}{11}$ of ? |
| c. | 16 is $\frac{4}{5}$ of? | 27 is $\frac{3}{5}$ of ? | 16 is $\frac{8}{9}$ of ? |
| d. | 12 is $\frac{2}{3}$ of? | 24 is $\frac{6}{7}$ of ? | 21 is $\frac{3}{5}$ of ? |
| e. | 25 is $\frac{5}{6}$ of? | 32 is $\frac{8}{9}$ of? | 28 is $\frac{14}{15}$ of? |
| f. | 30 is $\frac{6}{8}$ of ? | 15 is $\frac{5}{8}$ of ? | 64 is $\frac{8}{11}$ of ? |
| g. | 39 is $\frac{13}{16}$ of? | 49 is $\frac{7}{10}$ of ? | 48 is $\frac{6}{8}$ of ? |
| h. | 33 is $\frac{3}{7}$ of ? | 45 is $\frac{9}{10}$ of ? | 84 is $\frac{6}{9}$ of ? |
| i. | 16 is $\frac{4}{9}$ of ? | 24 is $\frac{3}{7}$ of ? | 16 is $\frac{8}{11}$ of ? |

DECIMALS

There are two ways to express a part of a whole, either by fraction or by decimals. You have just studied fractions. We now proceed to the study of decimals:

For example:

The common fraction $1/10$ is written as the decimal fraction -- .1

The " " $7/10$ " " " " " " -- .7

The " " $27/100$ " " " " " " -- .27

The " " $7/100$ " " " " " " -- .07

In other words it is possible to express a part of a whole, namely one tenth, either by a fraction as $1/10$ or by a decimal fraction, .1

We can think of fractions and decimals as tools, if we like. In a similar fashion we can think of an axe and a saw as tools. Either can be used to cut a log into pieces. One man may use an axe very expertly and see no reason why he should learn to use a saw. But his curiosity may lead him to attempt to use the new tool. He may become discouraged because he finds it difficult to handle. He is apt to say that it can't compare with this axe and that the saw slows him up. Another man may look at this matter of a new tool in a different manner. Suppose he has witnessed an expert use a saw. If he thought about the difference, he probably compared the effects of the two tools. In some such way, perhaps unconsciously, he came to believe that the saw created less waste and what's more, that it cut a log a lot faster than an axe. Probably some such thoughts would lead this second man to try to learn how to use the new tool. The hardest job would be learning.

Now it is quite possible that when decimal fractions were first tried, many persons had the same ideas as the first man, while still others were like the second man.

New tools are constantly being invented all the time. One of the important features of education is to learn new methods and then use them. Of course all new methods are not valuable. The better educated a person becomes the better position he is in to discover for himself what methods are of value. Some of us may have a great deal of education, yet fail to recognize useful tools from useless tools.

When you think of it, we almost always think of a part of an inch as a fraction, as $3/16$, $1/2$, $1/4$, $1/32$. On the other hand, when we write dollars and cents, we write them as decimal fractions; as:

\$ 1.25 \$ 3.41

\$ 1.12 \$ 6.08

A little thought on why we do this suggests several possibilities. We are accustomed to speak of $3/16$ of an inch. This is easier to say than one thousand eight hundred seventy-five ten-thousandths of an inch (0.1875 inch). Moreover the ruler shows the inch divided into sixteenths and not decimal fractions. Since this is so, we naturally read off what we see, as $3/16$ for instance, and record this distance. There might be much error if we relied on everyone to remember that $3/16$ equalled .01875.

On the other hand, we are not accustomed to think of dollars and cents as fractions, as

$\$ 1-1/4$ $\$ 1-3/4$ $\$ 6-08/100$ $\$ 3-41/100$

Six dollars and eight cents is a little easier to say perhaps than six dollars and eight one hundredths.

EXERCISE 20

Read these fractions and describe the method of writing them both as a common fraction and a decimal fraction.

	C.F.	D.F.
a. three tenths	_____	_____
b. nine tenths	_____	_____
c. one tenth	_____	_____
d. eight hundredths	_____	_____
e. ninety nine hundredths	_____	_____
f. four tenths	_____	_____
g. three hundredths	_____	_____
h. three thousandths	_____	_____
i. three ten thousandths	_____	_____
j. sixteen hundred thousandths	_____	_____
k. two thousand seventy-five hundred thousandths	_____	_____

Terms

When we speak of three "places" or four "places" etc., we refer to the actual number of integers to the right of the decimal point.

EXERCISE 21

Designate the number of "places" in each example below:

	<u>Number of places</u>
a. 4.6713	_____
b. 36.75	_____
c. 14.16	_____
d. 3.1416	_____
e. .007	_____
f. .175	_____
g. .00001	_____
h. 13.671	_____
i. 16.082	_____
j. 3.47	_____
k. 7.44	_____
l. 17.746781	_____

EXERCISE 22

Write the common fraction, the decimal fraction, and the number of "places" of each of the following:

	<u>C.F.</u>	<u>D.F.</u>	<u>No.Places</u>
a. eight hundredths	_____	_____	_____
b. four thousandths	_____	_____	_____
c. two tenths	_____	_____	_____
d. nine tenths	_____	_____	_____
e. three ten thousandths	_____	_____	_____
f. eight hundred seventy-three thousandths	_____	_____	_____
g. seventy-five hundred thousandths	_____	_____	_____

EXERCISE 22 (Continued)

	C.F.	D.F.	No. Places
h. two hundred fifteen ten thousandths	_____	_____	_____
i. twenty-seven thousandths	_____	_____	_____
j. nine thousand one hundred eighty-two ten thousandths	_____	_____	_____
k. nine tenths	_____	_____	_____
l. twelve hundredths	_____	_____	_____
m. seven thousand one hundred thirty-nine ten thousandths	_____	_____	_____
n. seven thousand one hundred thirty-nine hundred thousandths	_____	_____	_____
o. two thousand seventy- eight ten thousandths	_____	_____	_____
p. three hundred twenty-one thousandths	_____	_____	_____

ADDITION OF DECIMAL FRACTIONS

When decimal fractions are added, the decimal points appear in a vertical (straight up and down) column, so that tenths, hundredths, and so on are in the same line.

$$\begin{array}{r}
 16.\overset{.7}{4} \\
 3.2 \\
 \hline
 \end{array}$$

↑

Before adding any decimal fractions, it is a good practice to first write the decimal point below the line at the spot where it should be. It should be directly beneath the decimal points above the line. In the example shown, this place is where the point of the arrow is.

EXERCISE 23

Add the following:

	(1)	(2)	(3)	(4)	(5)
a.	$\begin{array}{r} .7 \\ .3 \\ \hline \end{array}$	$\begin{array}{r} .4 \\ .6 \\ \hline \end{array}$	$\begin{array}{r} .6 \\ .5 \\ \hline \end{array}$	$\begin{array}{r} .3 \\ .8 \\ \hline \end{array}$	$\begin{array}{r} .6 \\ .7 \\ \hline \end{array}$
b.	$\begin{array}{r} .4 \\ 1.2 \\ \hline \end{array}$	$\begin{array}{r} 4.1 \\ 5.2 \\ \hline \end{array}$	$\begin{array}{r} 6.8 \\ 9.4 \\ \hline \end{array}$	$\begin{array}{r} 6.7 \\ 8.2 \\ \hline \end{array}$	$\begin{array}{r} 9.1 \\ 8.01 \\ \hline \end{array}$
c.	$\begin{array}{r} .07 \\ .89 \\ \hline \end{array}$	$\begin{array}{r} .27 \\ .62 \\ \hline \end{array}$	$\begin{array}{r} .33 \\ .66 \\ \hline \end{array}$	$\begin{array}{r} .65 \\ .34 \\ \hline \end{array}$	$\begin{array}{r} .02 \\ .002 \\ \hline \end{array}$
d.	$\begin{array}{r} 2.1 \\ 2.01 \\ \hline \end{array}$	$\begin{array}{r} 3.001 \\ 6.010 \\ \hline \end{array}$	$\begin{array}{r} 7.34 \\ 6.82 \\ \hline \end{array}$	$\begin{array}{r} 6.82 \\ 9.00 \\ \hline \end{array}$	$\begin{array}{r} 16.27 \\ 4.72 \\ \hline \end{array}$
e.	$\begin{array}{r} .723 \\ .12 \\ \hline \end{array}$	$\begin{array}{r} .902 \\ .4 \\ \hline \end{array}$	$\begin{array}{r} .321 \\ .09 \\ \hline \end{array}$	$\begin{array}{r} .9001 \\ .012 \\ \hline \end{array}$	$\begin{array}{r} .85 \\ .9 \\ \hline \end{array}$

SUBTRACTION OF DECIMAL FRACTIONS

When one decimal fraction is subtracted from another, the figures should be so placed that tenths will be under tenths, hundredths under hundredths, and so on. The decimal points will thus appear in a vertical column.

Example: Subtract .487 from .5

$$\begin{array}{r} .5 \\ .487 \\ \hline .013 \end{array}$$

In this incident, ciphers to the right of .5 are assumed. That is .5 can be visualized as .500. The addition of the ciphers have not altered the value of .5

EXERCISE 24

Find the difference by subtraction:

	(1)	(2)	(3)	(4)
a.	$\begin{array}{r} .25 \\ - .125 \\ \hline \end{array}$	$\begin{array}{r} .2 \\ - .0001 \\ \hline \end{array}$	$\begin{array}{r} .7 \\ - .699 \\ \hline \end{array}$	$\begin{array}{r} .14449 \\ - .12315 \\ \hline \end{array}$
b.	$\begin{array}{r} .796 \\ - .506 \\ \hline \end{array}$	$\begin{array}{r} .5019 \\ - .0201 \\ \hline \end{array}$	$\begin{array}{r} .001 \\ - .0001 \\ \hline \end{array}$	$\begin{array}{r} .76852 \\ - .49736 \\ \hline \end{array}$
c.	$\begin{array}{r} .7 \\ - .235 \\ \hline \end{array}$	$\begin{array}{r} .325 \\ - .0475 \\ \hline \end{array}$	$\begin{array}{r} .9801 \\ - .5766 \\ \hline \end{array}$	$\begin{array}{r} .21359 \\ - .09078 \\ \hline \end{array}$
d.	$\begin{array}{r} .16 \\ - .1236 \\ \hline \end{array}$	$\begin{array}{r} .271 \\ - .046 \\ \hline \end{array}$	$\begin{array}{r} .4 \\ - .003 \\ \hline \end{array}$	$\begin{array}{r} .9201 \\ - .009 \\ \hline \end{array}$
e.	$\begin{array}{r} .27 \\ - .167 \\ \hline \end{array}$	$\begin{array}{r} .1469 \\ - .1236 \\ \hline \end{array}$	$\begin{array}{r} .67 \\ - .029 \\ \hline \end{array}$	$\begin{array}{r} .854 \\ - .732 \\ \hline \end{array}$

SUBTRACTION OF MIXED DECIMALS

The process of subtracting mixed decimals is the same as that of subtracting decimal fractions. The decimal points must be placed in a vertical column; with the whole number values on the left and the fractional value on the right.

EXERCISE 25

Subtract the following:

	(1)	(2)	(3)
a.	$\begin{array}{r} 1000.0001 \\ - 1.1 \\ \hline \end{array}$	$\begin{array}{r} 5138.7343 \\ - 4917.9872 \\ \hline \end{array}$	$\begin{array}{r} 256.303 \\ - 199.545 \\ \hline \end{array}$
b.	$\begin{array}{r} 243.66 \\ - 128.35 \\ \hline \end{array}$	$\begin{array}{r} 2109.0098 \\ - 143.7786 \\ \hline \end{array}$	$\begin{array}{r} 405.001 \\ - 31.786 \\ \hline \end{array}$

MULTIPLICATION OF DECIMALS

If you bought .7 lbs. of candy at \$.90 a lb., you would multiply $.7 \times .90$ to obtain \$.63, the cost.

The process used in multiplying decimal fractions is the same as that used with whole numbers. The fractional value of the product is indicated by showing as many figures at the right of the decimal point as there are figures at the right of the decimal points in both the multiplier and the multiplicand.

The illustration below shows the process of multiplying .671 by .015; and .047 by .35

$$\begin{array}{r} .671 \\ \times .015 \\ \hline 3355 \\ 671 \\ \hline .010065 \end{array}$$

The solution at the left shows the multiplication of two decimals that have the same denominator (1,000); the one at the right, the multiplication of the decimals that have different

$$\begin{array}{r} .047 \\ \times .35 \\ \hline 235 \\ 141 \\ \hline .01645 \end{array}$$

denominators. Observe that in each answer there are as many figures at the right of the decimal point as there are in both the multiplier and the multiplicand. If there are not enough figures in the product, additional ciphers must be prefixed so that the decimal point may appear in the correct position.

EXERCISE 26

Do the following multiplication of decimals:

(1)

a. $.0725 \times .072$

b. $.0075 \times .005$

c. $.2653 \times .325$

d. $.009 \times .008$

e. $.6562 \times .598$

f. $.3671 \times .673$

(2)

$.3765 \times .012$

$.009965 \times .9$

$.7654 \times .87$

$.2653 \times .325$

$.2009 \times .675$

$.467 \times .899$

EXERCISE 26 (Continued)

(1)	(2)
g. $4981 \times .9009$	$337 \times .1416$
h. $762 \times .635$	$225 \times .13$
i. $3774 \times .1045$	$6725 \times .7631$
j. $1742 \times .1492$	$1883 \times .005$
k. $3774 \times .1045$	$4752 \times .367$
l. 9.887×100.6	321.175×174.258
m. 35.42×625.8	75.3908×214.432
n. 18.6×3.1416	625.107×4.00807
o. 763.25×2214.6	876.01×6.00071
p. 4563.2×329.43	1967.27×134.67
q. 55.424×1.2345	87.67×87.67

Multiplication of decimals by 10 or multiples of 10, as 10, 100, 1000, 10,000., and so on.

Example:

$$\begin{array}{r} 3.7 \\ 10 \\ \hline 37.0 \end{array}$$

By multiplying by 10 the decimal in the multiplicand is moved one place to the right.

$$\begin{array}{r} 3.7 \\ 100 \\ \hline 370.0 \end{array}$$

By multiplying by 100 the decimal in the multiplicand is moved two places to the right.

In other words, we can say that for every cipher in the multiplier 10, 100, 1000 and so on, the decimal is moved one place to the right.

EXERCISE 27

At sight multiply the following by 10, 100, and 1000.

	(1)	(2)	(3)	(4)	(5)
a.	.14	6.7	.27	0.02	.01
b.	.8	.13	.02	.001	.0276
c.	.017	.267	.001	.067	.035
d.	.432	.067	.321	.481	.867
e.	.9	.82	.071	.67	.031
f.	.54	.054	.09	.371	.0001

EXERCISE 28

Multiply the following by

	(1)	(2)	(3)	(4)	(5)
a.	10 x \$.01	\$.001	1 mil	6 mils	4.6
b.	1000 x \$.01	\$.003	3 mils	.5 mils	3.82
c.	100 x 1 mgn	10 mgn	1000 mgn	.5 mgn	.06 mgn
d.	10 x 1 mm	65 mm	.03 mm	1 inch	\$.03
e.	1000 x 1 mil	.1 mil	14.3	6.01	.001
f.	100 x 2¢	10¢	6 mils	.006	.0321
g.	1000 x .0246	.7841	7.643	867.1	.00001
h.	10,000 x .0067	.3742	8.743	19.43	.00001

DIVISION OF DECIMALS

The process of dividing decimal fractions is the same as that used with whole numbers. The position of the decimal point in the quotient is determined by the number of decimal places in the dividend and the divisor. The number of places in the quotient is equal to the number of places in the dividend minus the number in the divisor.

Example:

$$\begin{array}{r} .315 \overline{) .1230000} \\ \underline{945} \\ 2850 \\ \underline{2835} \\ 1500 \\ \underline{1260} \\ 240 \end{array}$$

$.1230000 = 7$ places in dividend

$.315 = 3$ places in divisor
 $\underline{4}$ places in quotient

There is another way to determine where the decimal point goes.

Example:

$$.315 \overline{) .1230000}$$

When the decimal point is moved to the right, the number is multiplied by 10, or 100, or 1000 and so on, depending how far the point is moved.

$$.315 \times 1000 = 315$$

To make $.315$ a whole number, move decimal point three places to the right, which is the same as multiplying by 1000.

$$\begin{array}{r} .123000 \times 1000 \\ \hline .315 \times 1000 \end{array}$$

If the divisor is multiplied by 1000, the dividend must be multiplied by 1000 also.

$$.1230000 \times 1000 = 123.0000$$

$$.315 \times 1000 = 315$$

$$\begin{array}{r} 3 \\ 315 \overline{) 123.00} \\ \underline{945} \end{array}$$

$$\begin{array}{r} x3 \\ 315 \overline{) 123.00} \\ \underline{945} \end{array}$$

$$\begin{array}{r} x3904 + \\ 315 \overline{) 123.000} \\ \underline{945} \\ 2850 \\ \underline{2835} \\ 1500 \\ \underline{1260} \\ 240 \end{array}$$

The problem then resolves itself into dividing 315 into 123. The rule to follow is this: put the first figure of the quotient (3) over the last figure of the product (5) that results from multiplying the divisor (.315) by the first quotient figure (3). Next place the decimal point directly above the decimal point in the dividend. In this case, an x is placed directly above the decimal point, so as to clearly indicate the location.

Then proceed with the problem,,keeping the decimal in place.

Example:

Divide .012 by 6

$$6 \overline{) .012}$$

The process is the same.

$$\begin{array}{r} 2 \\ 6 \overline{) .012} \\ \underline{12} \end{array}$$

The first figure of the quotient goes over the last figure of the product, 12.

$$\begin{array}{r} x2 \\ 6 \overline{) .012} \end{array}$$

The decimal point in the quotient goes over the decimal point in the dividend. Its location is marked by x.

$$\begin{array}{r} .002 \\ 6 \overline{) .012} \end{array}$$

The gap between the decimal point is filled in with ciphers, one over each figure in the dividend until 2 is reached. In this case there are two ciphers.

$$.002 \times 6 = .012 \quad \text{Proof.}$$

$$\text{quotient} \times \text{divisor} = \text{dividend}$$

Example:

Divide .414 by .0375

$$\begin{array}{r} 1 \\ .0375 \overline{) .414} \\ \underline{375} \end{array}$$

This problem differs from the other examples, in that there are more places in the divisor than in the dividend. You can go no further, as there are no more figures to "bring down".

$$\begin{array}{r}
 .0375 \overline{) .414000} \\
 \underline{375} \\
 390 \\
 \underline{375} \\
 1500 \\
 \underline{1500} \\
 0
 \end{array}$$

In order to carry the division out further, you add as many ciphers to the right of the last figures, as may be needed. As a rule quotients are "carried out" to two "places".

$$\begin{array}{r}
 .0375 \overline{) 11.04} \\
 \underline{.414000} \\
 .414000
 \end{array}$$

$$\begin{array}{rcl}
 .414000 & = & 6 \text{ places} \\
 .0375 & = & 4 \text{ places} \\
 \hline
 & & 2 \text{ places in quotient}
 \end{array}$$

EXERCISE 29

Do the following divisions:

- | | (1) | (2) | (3) |
|----|--------------------|----------------------|------------------------|
| a. | $.3544 \div .22$ | $.21 \div .0007$ | $.26 \div .0076$ |
| b. | $.2096 \div .04$ | $.45 \div .1312$ | $.2245 \div .17$ |
| c. | $.7853 \div .37$ | $.63 \div .0021$ | $.42 \div .0006$ |
| d. | $.4 \div .2$ | $400 \div .002$ | $36.7 \div .72$ |
| e. | $4 \div .2$ | $4.6 \div .016$ | $8.9 \div .0162$ |
| f. | $4 \div .02$ | $37.2 \div .026$ | $.92 \div .472$ |
| g. | $7642 \div .21$ | $.6875 \div .43$ | $.4756 \div 1137$ |
| h. | $5375 \div .55$ | $.3413 \div 13$ | $.5837 \div 21137$ |
| i. | $9847 \div .87$ | $.8009 \div 11$ | $.6847 \div 458$ |
| j. | $77.54 \div 21.42$ | $2781.4 \div 76.398$ | $643.14 \div 76.374$ |
| k. | $13.487 \div 367$ | $5869.5 \div 23.67$ | $9876.54 \div 25.7643$ |
| l. | $365.6 \div 121.9$ | $43.006 \div 2.5467$ | $23.473 \div 47.362$ |

DIVISION OF DECIMALS BY TEN AND MULTIPLES OF 10, as 10, 100,

1000 and so on.

The process is the exact reverse of multiplication by 10 and its multiples. The decimal point is moved to the left one place for each cipher in the divisor.

Examples:

$$3.7 \div 10 = .37$$

Move decimal one place to the left.

$$3.7 \div 100 = .037$$

Move decimal two places to left.

$$3.7 \div 1000 = .0037$$

Move decimal three places to left.

EXERCISE 30

Divide the following by:

	(1)	(2)	(3)	(4)	(5)
a. 10	146.2	13	167	.01	.1
b. 100	16.2	2	.08	.010	6.4
c. 1000	.002	241	67.8	\$1000	\$10
d. 10	\$341	67¢	16 mm	381 mgn	41 mils
e. 100	271 lbs.	3.21	6 gms	3 gr.	40 oz.
f. 1000	500 mils.	65 gm	87 mm	2.86	\$14.21
g. 10	\$.35	100 mm	125 gm	6.4 gr.	68 mgn
h. 100	.04 gm	.068 gr.	.92 oz.	16.6 oz.	1.42

EXERCISE 31

Reading the following decimal fractions:

	(1)	(2)	(3)
a.	.425	.7485	.14166
b.	.0274	.30024	.74675
c.	.76549	.3781	.32681
d.	.794	.00048	.42643
e.	.00076	.408	.67677
f.	.378	.0706	.92431
g.	.546	.6243	.16812
h.	.037	.3701	.00046
i.	.165	.0024	.10078
j.	.674	.0635	.74654
k.	.875	.0785	.92465
l.	.926	.7432	.87365

Reading to the nearest hundredths, thousandths, ten thousandths, and so on.

Example: Read .794 to the nearest hundredths. The question to ask yourself is whether .794 is nearer to being .79 or .80; .794 lacks .004 from being .79; it also lacks .006 from being .80 - Hence the nearest hundredth is .79

Example: Read .425 to nearest hundredth. Is .425 nearer .43 or .42? Since .425 ends in 5, it is obvious that 5 is midway between .430 and .420 - When this is the case the rule is that the higher number is taken as the nearest hundredth. In this case the answer is .43

Reading to nearest thousandths

Example: Read .30024 to the nearest thousandth. The choice is between .300 and .301. The answer is determined by noting whether the figure to the right of the thousandth place is below five or five or above five. The figure is 2. Hence the nearest thousandth is .300. This can be read as .3 of course, since $300/1000$ after cancellation is really $3/10$.

EXERCISE 32

(Refer to the last exercise. Read the decimals in column 1, to the nearest hundredth; those in column 2, to the nearest thousandth; and those in column 3, to the nearest ten-thousandths.

R E V I E W

OF

FRACTIONS AND DECIMALS

(1)	(2)	(3)	(4)
a. $5 \overline{) .35}$	7 $\overline{) 1.428}$	8 $\overline{) 3.0}$	9 $\overline{) .4257}$
b. $4 \overline{) 8.24}$	5 $\overline{) .60}$	8 $\overline{) 7.0}$	.5 $\overline{) 1.475}$
c. $5 \overline{) .20}$	5 $\overline{) 0.025}$	4 $\overline{) 3.0}$	7 $\overline{) .0637}$
d. $3 \overline{) .4287}$	9 $\overline{) 8.37}$	3 $\overline{) 52.02}$	7 $\overline{) 1.484}$
e. $6 \overline{) 3.048}$	8 $\overline{) .0716}$	6 $\overline{) 32.406}$	9 $\overline{) 1.917}$

(1)	(2)	(3)
f. $64.432 \div 16$	$7.686 \div 105$	$.1161 \div 27$
g. $264.312 \div 36$	$1244.4 \div 307$	$743.986 \div 82$
h. $668.368 \div 74$	$.63 \div 15$	$16.215 \div 23$

	(1)	(2)	(3)
i.	$88.32 \div 23$	$3.6851 \div 43$	$.01554 \div 37$
j.	$91.205 \div 85$	$.055188 \div 146$	$33.626 \div 43$
k.	$.1081 \div 2.3$	$.06336 \div 1.32$	$378 \div 2.7$
l.	$1.36854 \div .18$	$.01625 \div .125$	$.001216 \div .038$

Oral

	(1)	(2)	(3)	(4)
m.	$.4 \div .2$	$.04 \div .2$	$.004 \div .2$	$.004 \div .02$
n.	$.04 \div .02$	$.48 \div .4$	$1.5 \div .03$	$.0036 \div .006$
o.	$.014 \div .2$	$8.432 \div .04$	$.015 \div .05$	$378 \div 2.7$

Convert to Decimal Fractions

p.	$1/2$	$1/3$	$1/4$	$1/5$
q.	$1/6$	$1/10$	$2/3$	$3/8$
r.	$7/8$	$5/6$	$3/4$	$1/8$
s.	$7/16$	$15/32$	$3/25$	$1/50$
t.	$7/15$	$3/7$	$1/15$	$1/11$
u.	$8/9 \div 4/3$	$11/12 - 5/8$	$7/9 \div 14/15$	$3/5 + 2/3$
v.	$4/5 \times 5/4$	$2/3 \times 5/4$	$3/8 \times 2/3$	$7/6 - 4/5$
w.	$7/16 \div 7/16$	$9-1/3 \div 1-1/16$	$8-4/5 \div 1-1/20$	$5/6 + 3/4$
x.	$1/5 + 1/8$	$9/16 \times 16/9$	$6-1/4 \times 12-1/2$	$37-1/2 \div 62-1/2$
y.	$5/6 \times 3/4$	$7/8$ of $2/3$	$3/5$ of $5/16$	$7/8$ of $5/6$
z.	$7-1/2 \div 1-1/4$	$9-1/2 \div 7-3/5$	$5/16 - 1/5$	$3/4 - 2/3$

Second Series

A. Convert the following to common fractions and add:

$$\begin{array}{r} .3 \\ .15 \\ .275 \\ .250 \\ \underline{.0250} \end{array}$$

B. Arrange the following fractions in order of size, placing the largest first:

.09 .07984 .1024 .03786 .061

C. If a bushel of potatoes contains 47.34 pounds of water, what is the weight of the water in a load containing 38.5 bushels?

D. A train ran 67.75 miles an hour for 2.4 hours. How many miles did it run?

E. A boy took 184 steps, each of which was 2.75 feet long. How far did the boy walk?

F. A field containing 17.375 acres yielded 22.4 bushels of wheat per acre. What was the total yield?

G. A pound of beef contains .166 pounds of fat. How much fat in a 4.5 pound roast?

H. If a gallon of milk weighs 8.6 pounds, what is the weight of the milk that may be put into a tank with a capacity of 114.5 gallons?

I. The number of inches of rainfall in a city for each of the first five months of the year was as follows: 4.3, 4.7, 3.6, 5.2, 6.1. What was the average rainfall for the five months?

J. A gallon of water weighs 8.3 pounds. What is the weight of the water in a tank that contains 146.25 gallons?

K. A field of 18.5 acres yielded 451.7 bushels of wheat. What was the average yield per acre?

L. A cubic foot of water weighs 62.5 pounds, and a cubic foot of gold weighs 19.3 times as much. What would be the weight of a cubic foot of gold? Of a cubic inch of gold?

M. Find the cost of 348 pounds of pork at \$9.25 per 100 pounds.

N. Find the cost of 4250 envelopes at \$2.60 per 1000.

- O. Find the cost of 7850 bricks at \$11.40 per 1000.
- P. Mrs. Johnson paid \$3.50 for a turkey which weighed 12.5 pounds. What was the price per pound?
- Q. The bank deposits and withdrawals of a merchant during a week were as follows:

	Deposits	Withdrawals
Monday.....	\$ 294.65	\$ 184.30
Tuesday.....	347.85	.....
Wednesday.....	792.60	473.85
Thursday.....	247.82	143.60
Friday.....	427.18	231.42
Saturday.....	527.86	321.43

What was the difference between the deposits and the withdrawals for the week?

- R. Mr. Adams paid \$28.40 for an automobile tire. At the end of 6142 miles the tire was worthless. What was the cost per mile for this tire?
- S. The area of Texas is 265,896 square miles. The area of Rhode Island is 1248 square miles. How many times is the area of Rhode Island contained in the area of Texas?
- T. A boy raised 62.5 bushels of corn on .75 acres. Find the yield per acre.
- U. Mr. Adams took a motor trip of 144.9 miles. During the first hour he traveled 24.3 mi., during the second, 23.9 mi., during the third hour, 26.8 mi. At what average speed per hour was it necessary to travel to complete the trip in the next 3 hours?

CHAPTER V.

HOW TO SOLVE A PROBLEM

You have now studied addition, subtraction, multiplication, and division of integers, of common fractions, and of decimal fractions. You are familiar with the measurement tables in common use in this country, and you know some of the practical short methods of computation. You can compute with some degree of speed and accuracy. It is now desirable that you learn further how to apply this knowledge to the solution of problems that arise in the Medical Corps. This is the true test of your knowledge of arithmetic.

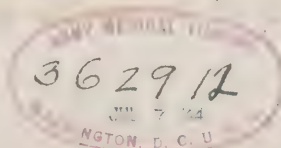
It is important that you develop the ability to analyze problems. Those whose daily work requires the solution of many problems must always think out the analyses, even though they do not write them out. In the problems that follow throughout this book you are asked to think out the analysis of each, and often to write it out. Such work will give you needed practice that will help you to solve the problems that arise when you later enter upon your household duties, your trade, or your profession.

Other things besides analysis are necessary if you are to solve the problems you meet. Your computations must be rapid and accurate; otherwise your work is of no value. Last, but very important, your figures must be neatly made and legible. Figures made carelessly cause a loss of time and money to yourself and to your employer. You may be willing to stand that loss, but you may be sure you will not find an employer who is willing to do so.

Below you will find a suggested method for attacking, that is, for analyzing a problem. You should study this carefully, and learn how to apply the method to other problems. Although there is no one best form of analysis, the one given here is a very good guide as to what an analysis should be. Study the statement of each problem thoroughly, think the solution through carefully, and do as much of the work as you can without pencil or paper. At the beginning, it is profitable to indicate the solution of every problem before you make your computations.

To Solve A Problem in Arithmetic

- I. Read the problem carefully so that you may understand
 - a. The facts that are stated or suggested.
 - b. What you are to find.
- II. Decide upon the operations that are to be used.
- III. Make the necessary computations accurately.
- IV. Check the result.



THE SOLUTION OF A PROBLEM

Find the cost of $4\frac{3}{4}$ yards of cloth at 56 cents a yard.

1. (a) The facts stated: The number of yards of cloth bought.
The price per yard.
- (b) What you are to find: The total cost of the cloth.
- II. The operation to be used: Multiplication.
- III. Computation: $4\frac{3}{4} = 19/4$
 $19/4 \times \$.56 = \2.66
- IV. Check the result: Do this by making the computation a second time.

THE SOLUTION OF A SECOND PROBLEM

When a dozen lemons sell for 54 cents, how many can be bought for 36 cents?

- I. (a) The facts stated: The selling price per dozen.
- (b) What you are to find: The number that can be bought for 36 cents.
- II. The operation to be used: Division.
- III. Computation: $1/12$ of $\$.54 = \$.045$, the cost of 1 lemon
 $\$.36 \div \$.045 = 8$, the number bought.
- IV. Check the result: Do this by making the computation a second time.

The way to solve such a problem is based on analysis or finding out the cost of one lemon. Since 12 lemons cost 54 cents, one lemon costs 12 into 54 cents or $1/12$ of $\$.54$, which is $\$.045$. One more step is necessary to get the answer. Further analysis is needed. You have 36 cents. One lemon costs $\$.045$ ($4\frac{1}{2}$ cents). How many lemons can you buy? In other words, how many times will $4\frac{1}{2}$ cents go into 36 cents?

Note to Pupil: In most business transactions it is customary to consider fractions of a cent amounting to $1/2$ or more as an extra cent. Thus, $\$.45\frac{1}{2}$ is considered as $\$.46$. If the fraction is less than $1/2$, it is usually discarded in the final result.

THE SOLUTION OF A THIRD PROBLEM

If 12 small radio sets cost a merchant \$168, what will 8 sets cost him at the same rate?

Solution:

$$\frac{\$168}{12} = \text{cost of one radio} = \$14$$

$$\$14 \times 8 = \text{cost of 8 radio sets.}$$

By the use of cancellation, this problem may be solved, thereby saving time.

$$\begin{array}{r} 14 \\ 168 \times 8 \\ \hline 12 \end{array} = \$112, \text{ cost of 8 sets.}$$

$$\begin{array}{r} .56 \quad 2 \\ 168 \times 8 \\ \hline 12 \\ 3 \\ 1 \end{array} = \$112.$$

This is an example of cancellation in which different figures happened to be cancelled.

EXERCISE 32

In solving the following problems, use the method of analysis suggested on Pages 50 & 51. Use cancellation whenever possible.

1. If a farm containing 240 acres is worth \$32,400, how much should be paid for 75 acres at the same rate?

Solution:

$$\frac{\$32,400 \times 75}{240} = ?$$

2. The daily noon temperatures for a week were: 58°, 49°, 54°, 61°, 53°, 56°, and 54°. What was the average for the week?

3. A farmer traded 18 dozen eggs, at 28 cents a dozen for sugar at 9 cents a pound. How many pounds of sugar did he receive?

4. In a laundry, 48 burners, each using 7 cubic feet of gas per hour, burn 7 hours a day for 6 days. What will be the gas bill at 90 cents a thousand cubic feet?
5. The circumference of a driving wheel of a locomotive is 22 feet. How many revolutions will this wheel make when the locomotive goes a mile?
6. How far will the locomotive mentioned in Problem 5 travel when a driving wheel makes 1000 revolutions?
7. When sound travels 1090 feet in a second, how far will it travel in 14 seconds?
8. At the rate given in Problem 7, how long will it take the report of a rifle to travel 14,170 feet?
9. If it takes light about 498 seconds to come from the sun to the earth, at the rate of 186,300 miles a second, what is the distance from the earth to the sun?
10. In a recent year 13,439,603 bales of raw cotton were produced in the United States. If a bale of cotton weighs 500 pounds, what was the production in pounds?
11. The receipts of a store for a week were: Monday \$268.40; Tuesday, \$313.92; Wednesday, \$284.63; Thursday, \$347.24; Friday, \$318.69; Saturday, \$423.72. What were the average daily receipts?
12. Harry's mother bought a table for \$34. She paid \$9 cash and the remainder at the rate of \$2.50 a week. How long did it take her to pay the bill in full?
13. If your pulse beats 72 times per minute, how many times does it beat in a day? In a year?
14. How many bushels of shelled corn are in a load containing 2352 pounds? (A bushel of shelled corn weighs 56 pounds.)
15. When children's stockings sell for $66\frac{2}{3}$ cents a pair, how many pairs can you buy for \$4.7
16. An automobile traveled a mile in 52 seconds. What was the speed per hour?
17. Find the number of seconds in 1942 years.
18. It is thought that the first life to appear on the earth occurred about 1,335,000,000 years ago; and that man first appeared about 50,000,000 years ago. Man's time is what fraction of the time that life has been present. In order to obtain a simple fraction for an answer, you must approximate.

19. If one gram of uranium generates in one year 0.000,000,000,125 grams of lead, how many grams of uranium would generate 1 gram of lead in one year?

20. A man skates 440 yards in $3\frac{1}{4}$ seconds. Find his speed in miles per hour.

21. A man runs 440 yards in 46.4 seconds. Find his speed per hour.

22. Man O' War ran $\frac{3}{4}$ of a mile in 1 minute, 12 seconds. Find speed per hour.

23. Mr. Brown in 1930 walked and ran 26 miles in 2 : 27 : 29.6 Find speed per hour.

CHAPTER VI

Metric System

Mathematics is a language, though we hardly ever think of it as such. You have been hearing many new words in your classes. A dictionary will tell you the meaning of such words as calorie, infection, pathogenic, ulna, shock and so on.

Tables, when we refer to them, tell us the meaning of various words used in the language of mathematics. A foot, we find is 12 inches; a meter is 39.37 inches. ($>$) means greater than; ($<$) means less than; ($=$) means equal.

There was a time long ago, before integers were in use, when the first eight numbers were represented by combinations of horizontal bars. Thus — stood for 3. — stood for 2. The way to write 32 would be — — .

All this was very complicated before a way was found to represent zero. Without some such means how could one write 320, 302, 3,200? Before the introduction of the 0, — had become Σ and — had become Z the original form of our 3 and 2.

Furthermore, there was a time, long ago, when fractions were unknown. For instance, as time went on, it was found that all measurements or all weights could not be expressed accurately by whole numbers alone. A piece of cloth $4\frac{1}{3}$ yards long could not be accurately measured by a 1 yard rule. It was found that the cloth was more than four yards and less than five yards. When, in time, man found that he could not measure out exactly a pound of flour, he divided it into ounces. Likewise, he divided a yard into feet; and later, feet into inches. Instead of developing fractions, smaller units were invented as an answer to the problem of measuring parts of a whole.

Later, fractions came more into use. Thus three fourths was written $3/4$. 45 minutes came to be spoken of as $3/4$ of an hour.

Complications arose in some instances. At one time $16-2/3$ digits equalled a foot. This, of course, created an inconvenience when one wished to express $3/4$ of a foot in a fraction. To get around this difficulty a new digit was formed so that each digit equalled $1/16$ of a foot. (There is considerable belief that this is true, but there is no proof.) Certainly an inch that is made up of 16 parts, is more easily divided into smaller fractions of an inch, than would be the case if an inch had 12, or 10, or 6 parts.

Express $1/8$ of an inch that has twelve equal parts. What problem does this raise?

There is another factor in the history of weights and measures. An example is that of troy weight, the weight commonly used by jewelers. During the 8th and 9th centuries, great fairs were held at several French villages, including TROYES. Here came also traders from all countries. In time it was discovered that the coins were so mutilated that it became necessary to sell coins by weight. The standard weight that the village of Troyes utilized, was later adopted for precious metal (as gold) and medicines in all parts of Europe. The troy ounce and the avoirdupois ounce were originally intended to have the same weight, but after the revision in Troyes it was found that the avoirdupois ounce was lighter by $42-1/2$ grains than the troy ounce. As a result of this development, the apothecaries of England/ must buy medicine by the avoirdupois system and compound (mix) them by the apothecaries or troy system.

In 1266, Henry III of England decreed that "an English silver penny called the sterling, round and without clipping, shall weigh thirty-two grains of wheat, well dried and gathered out of the middle of the ear".

In England there continued to develop modifications of the basic measures, the pound and the yard. We can indicate some of the units under the following headings:

Weights - ton, hundredweight, stone, pound, ounce.

Length - mile, furlong, rod, chain, yard, foot, inch.

Capacity - gallon, quart, pint, ounce.

quarter, bushel, peck, quart, pint.

All civilized nations have had experience similar to that of the English. Over a period of several thousand years, the various values of weights and measures have changed. The changes of course lead to confusion, an example of which is shown by the difference between a Troy ounce and an avoirdupois ounce.

What Henry III did, of course, was to establish a standard, which was what we call a rough standard, since well dried grains of wheat are not the same in weight, although they may be very nearly exact. A grain may be lighter than another by .01 grain, which is a small difference. But think what a difference would be made by 32 grains? Let's see: $32 \times .01 = .32$ grains. That means that one silver penny (32 grains) would be too light in weight by .32 grain. Thus the king attempted to create a standard by which disputes might be settled and accuracy maintained.

In time there arose new troubles. When the first bacteria were seen under a microscope, the language of mathematics was at a loss to tell of their size. How was one to express the diameter of a human red blood cell? Of course, the diameter could be expressed as

$\frac{36}{127,000}$ inch. That was one way. Another method was to devise new and smaller units, as had been done for the foot and other weights and measures.

There was a second possible means, one that has been thought of before. Instead of having an inch divided into sixteenths; a foot divided into twelfths; yards into thirds; miles into rods; instead of having land miles and nautical miles; troy ounces and avoirdupois ounces; instead of all this why not try to relate in some way all these weights and measures? Instead of thirds, twelfths, sixteenths, and so on, why not base a new system on 10, 100, and 1000?

By 1800, the French had introduced and adopted a new system, The Metric System which is widely used throughout the world today. The unit of length is the meter, which until very recently has been considered one forty millionths part $\left(\frac{1}{40,000,000} \right)$ of the circumference of the earth around the poles, and is equivalent to 39.37 inches.

The unit of volume or capacity is the liter, which is the volume of the cubic decimeter. It is also defined as the volume occupied by the mass of 1 kilogram of distilled water at its maximum density (4° C). It is equivalent to 2.1134 pints.

The unit of weight is the gram, which is the weight of one milliliter of distilled water at its maximum density (4° C). It is equivalent to 15.432 grains.

The unit of microscopic measurement is the micromillimeter, or micron, which is a thousandth part of a millimeter.

In Paris, France, there are preserved (at least up to the time of World War II) the models or standards of the meter and kilogram from which all prototypes are made.

The United States prototypes, made of a platinum-iridium alloy, are kept in the Bureau of Standards at Washington, D. C. and are used for standardizing all weights and measures used in the United States.

The denominations of this system are multiplied by the Greek words deka, meaning ten; hecto, meaning hundred; and kilo, meaning thousand, and are divided by the Latin words deci; meaning one tenth; centi, meaning one hundredth; and milli, meaning one thousandth.

deka	hecto	kilo	deci	centi	milli
ten	hundred	thousand	tenth	^{one} hundredth	^{one} thousandth
$\frac{10}{1}$	$\frac{100}{1}$	$\frac{1000}{1}$	$\frac{1}{10}$	$\frac{1}{100}$	$\frac{1}{1000}$
10	100	1000	0.1	0.01	0.001

"meter" for length	Micron = .001 mm
"gram" for weight	
"liter" for capacity or volume	

Common Abbreviations:

m - meter
 mm - millimeter
 gm - gram
 mgm - milligram
 l. - liter
 c.c.- milliliter

To return a moment to the problem of expressing the size of the red blood cell. Our choice is between $\frac{36}{127,000}$ inch or 7.2 microns. The new word is micron. It can be looked up in mathematical tables if you forget its meaning; just as you can look up the meaning of a new word heard in class or read in a book. 7.2 microns = .0072 mm.

THE METER

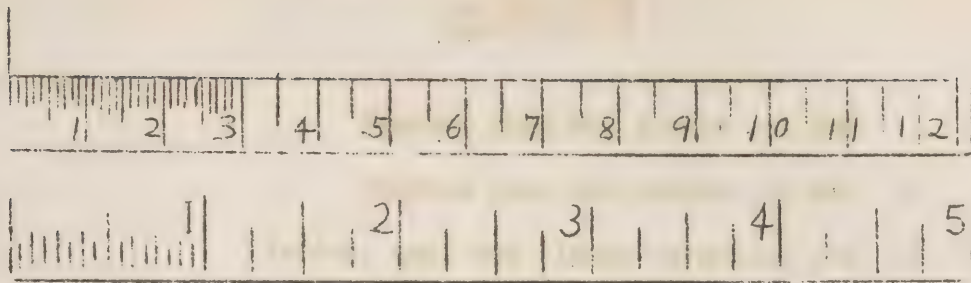


Fig. 3

Comparison of the English and metric systems of linear measure.

The metric scale shown above represents 12 and a fraction centimeters (cm). Each centimeter is divided into 10 millimeters. A decimeter is $1/10$ of a meter; it is also another name for 10 cm.

When the meter and yard were compared it was found that:

One meter = 39.37 inches.

The meter is divided into:

Tenths, called decimeters (dm.)

Hundredths, called centimeters (cm)

Thousandths, called millimeters (mm)

The multiples of a meter are:

10 meters, called one decameter (Dm.)

100 meters, called one hectometer (hm.)

1000 meters, called one kilometer (km.)

10,000 meters, called one myriameter (Mm)

EXERCISE 33
(Do in Class)

1. One cm. equals how many inches?
2. One mm. equals how many inches?
3. One decimeter equals how many inches?
4. One kilometer equals how many miles?
5. One inch equals how many cm?
6. Express your height in meters. Carry to three decimal places.
7. The Olympic races use the Metric System of weights and measures. Convert:
100 meters to yards.
440 yards to meters.
1 mile to meters.
8. In Europe the Metric System is used almost everywhere. Convert to Metric System:
46 miles per hour
384 miles per hour
100 miles per hour
9. A gun has a 75 mm. diameter. Express in inches.
10. Twelve inches equal how many
centimeters -
millimeters -
meters -
11. A dive bomber drops about 9000 ft. in 14 seconds. Express .9000 ft. as kilometers. Express the speed as kilometer per hour; as miles per hour.
12. When sound travels 332 m. per second, how long will it take the report of a gun to travel 4 Km.?

EXERCISE 34

Convert to centimeters

(1)	(2)	(3)	(4)	(5)	(6)
a. 13-1/4 in.	16 dm.	8 in.	3 ft.	.6 m.	18 mm.
b. 3-1/3 yd.	2.1 miles	16 dm	14 in.	18.2 m.	3.9 mm.
c. 3/4 ft.	2/3 yd.	1/8 miles	3/16 in.	7/8 in.	.25 ft.

Convert to meters

d. 2-1/2 miles	3 in.	4 ft.	.6 miles	7/5 miles	68 inches
e. 28 cm.	360 mm.	1.8 dm.	18 Dm.	7 ¹ / ₄ mm.	6 cm.

THE LITER

In the metric system, we speak of a liter of milk, whereas in the English System the comparable volume is the quart. Like the meter, the liter can be divided into tenths, hundredths, and thousandths.

The liter is related to the meter in the following manner. A square container, whose sides and height are exactly 10 centimeters (1/10 of a meter, or a decimeter) holds exactly one liter of distilled water at 4° C. You may be surprised that a temperature is mentioned. There is a good reason. As water increases in temperature it expands, that is, it takes up more space.

As mentioned the liter is divided into:

Tenths, called deciliters (dl.)

Hundredths, called centiliters (cl.)

Thousands, called milliliters (ml.)

The multiples of a liter are:

10 liters, called ... one decaliter (Dl.)
100 liters, called ... one hectoliter (hl.)
1000 liters, called ... one kiloliter (kl.)

Since the sides and height of this square container are each 10 centimeters, we can obtain the ^{capacity} ~~volume~~ (cubic measure) by multiplying side x side x height, or:

10 cm. x 10 cm. x 10 cm. = 1000 cubic cm.

1000 cubic cm. of distilled water at 4° C. are called one liter.

1 cubic cm. of distilled water at 4° C. is 1/1000 of distilled water, hence 1 cubic cm. can be expressed as 1 milliliter, though the common expression for 1/1000 of a liter is 1 c.c. which is an abbreviation for 1 cubic centimeter.

One more point is worth explanation at this moment. So far the connection between the linear measures and the volume measures has been related in the closest manner. Is there any connection with weight? Yes. For 1 c.c. of distilled water at 4° C. weighs exactly one gram. And 1000 c.c. weighs 1000 grams. But, we will return to the study of the metric weights in subsequent pages.

Fig. 4 represents a square container whose sides and height are 10 centimeters each (1 decimeter). 1000 cubic centimeters is another way of saying 1 cubic decimeter.

To sum up. From the linear measure of the metric system, we can calculate the capacity (or volume) measure, or liter.

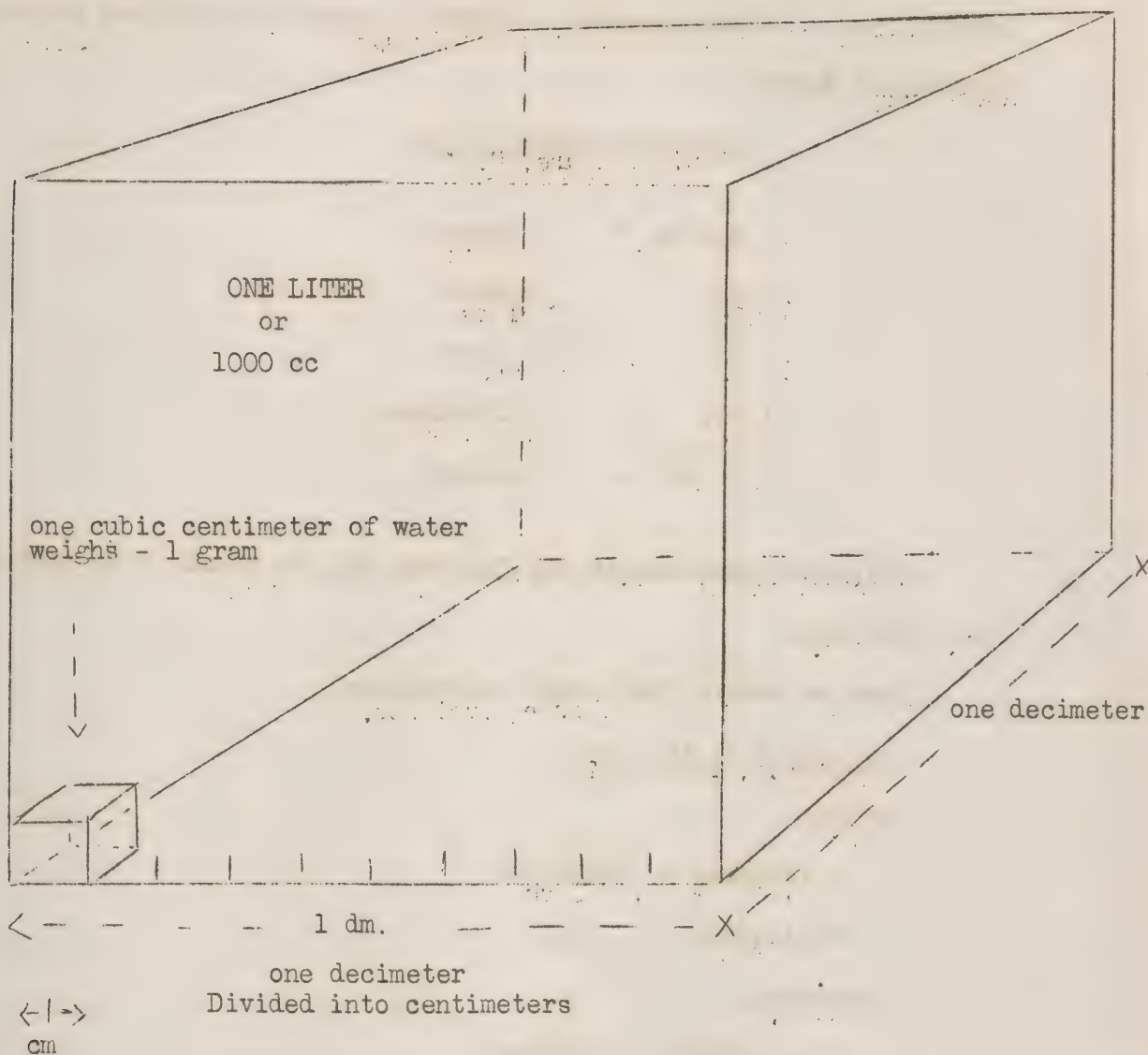


Fig. 4 One cubic decimeter. The volume of one cubic decimeter is 1 liter. Moreover a liter of distilled water at 4° centigrade temperature, (39.2° F) weighs one kilogram.

The weight of distilled water at 4° C contained in a cube of 1/1000 of a liter is equal to a GRAM = 15.432 grains and measures 1 milliliter (one cubic centimeter).

It is obvious that the metric system is clear cut and not difficult to understand. As this new system was introduced it was compared to the English System. We have studied these comparisons of linear measure. The capacity measures must be compared in a similar way. We shall compare the metric system with our own American Apothecary System.

Liquid measure, U. S.

1 gallon	=	4 quarts
1 qt.	=	2 pints
1 pt.	=	16 ounces
1 oz.	=	8 fluidrams
1 f. dr.	=	60 minims

By actual measurement one fluidram will be found to be equivalent to 3.6962 c.c.

Next we should find other equivalents.

How many c.c. in 1 oz.?

Method:

$$1 \text{ fluidram} = 3.6962 \text{ cc}$$

$$8 \text{ fluidram} = 1 \text{ oz.}$$

Therefore,

$$8 \times 3.6962 = 29.573 \text{ cc}$$

How many c.c. in 1 pint?

Method:

$$1 \text{ fluidram} = 3.6962 \text{ cc}$$

$$1 \text{ oz.} = 29.573 \text{ cc}$$

$$16 \text{ oz.} = 1 \text{ pint}$$

Therefore,

$$16 \times 29.573 \text{ cc} = 473.168 \text{ cc}$$

Approximate values.

Such values as 3.6962 cc; 29.573 cc; 473.168 cc are exact metric equivalents. However in your work in the ward, there is no reason to use these figures. Instead, round numbers are used. By so doing, the chance of error is greatly reduced. Moreover, it is perfectly safe to give a patient 4 cc of some medicine, instead of 3.6962 cc. Such a round number as 4 cc is obviously easier to "handle" than 3.6962 cc. In a like manner, the following approximate values are in common use. They should be learned.

<u>Apothecary</u>	<u>Metric Eq.</u>	<u>App. Value</u>
16.23 minims	1.00 cc	16 minims
1 oz.	29.573 cc	30. cc
8 oz.	236.584 cc	240 cc

Problem (Do in class)

If 3.6962 cc equals 1 fluidram (60 minims) find how many minims are in 1 cc. What do you think would be a satisfactory approximate value? Fill in your answers in the space provided above.

Apothecary	Metric Eqw.	App. Value	Household Measure	Symbols
1 gal. = 4 qts.				
1 qt. = 2 pts.	946.33 c.c.			
1 pt. = 16 oz.	473.168 c.c.			
1 oz. = 8 f.dr.	29.573 c.c.	240.0 c.c. - - - 1 tumblerful		$\frac{3}{\text{VIIII}}$
		30.0 c.c.		$\frac{3}{\text{I}}$
		16.0 c.c. - - - 1 tablespoon - - -		$\frac{3}{\text{ss}}$
1 f.dr. = 60 M. $\frac{1}{2}$	3.6962 c.c.	4.00 c.c.	1 teaspoon - - -	$\frac{3}{\text{r}}$
m - - - - -	1.00 c.c.			

Figure 5

A table showing apothecary measures with metric equivalents and approximate values. You should know the approximate values given in this table. Fill in the approximate value of minims in the last row.

SPECIAL ATTENTION

Pay close attention to the approximate value of 1 fluidounce.

In figuring the number of ounces in 360 cc. use 30 cc as the amount equivalent to an ounce.

You will become confused and moreover you will obtain a wrong answer, if you find the number of fluidrams first, then divide by 8 to get the number of ounces.

Right Way

$$\frac{360}{30} \frac{\text{cc}}{\text{cc}} = 12 \text{ oz.}$$

Wrong Way

$$\frac{360 \text{ cc.}}{4 \text{ cc.}} = \overset{90}{\cancel{16}} \text{ fl.dr.}$$

$$\frac{90 \text{ fl.dr.}}{8} = 11.25 \text{ oz.}$$

In the Medical Corps, the metric capacity system is employed in the following practices:

1. Liquid medicines, ordered by the medical officers, are usually put in a bottle of one of the following sizes:

$\frac{3}{8}$ oz.
 $\frac{3}{8}$ T
 $\frac{3}{8}$ II
 $\frac{3}{8}$ IV

$\frac{3}{8}$ VIII
 $\frac{3}{8}$ XVI
 $\frac{3}{8}$ XXXII

2. The amount of medicine a patient is to receive is ordered by the medical officer. The following are common doses or amounts:

$\bar{z} \bar{i}$ or one ounce.
 $\bar{z} \bar{iv}$ or $\bar{z} \bar{ss}$ or one tablespoon or 16 cc.
 $\bar{z} \bar{i}$ or one teaspoon or 4 cc.
 $\bar{z} \bar{ss}$
 $\bar{i} \text{ cc}$
0.5 cc
 $m \bar{i}$ to $m \bar{xv}$.

3. The amount of fluid (water, milk, fruit juices, coffee, etc.) that a patient takes in a 24 hour period, must at times be determined. The figuring may be done in ounces or c.c., according to the order given.

4. The amount of urine that a patient passes in 24 hours must at times be calculated. The figuring is likewise in ounces or c.c.

5. "Fluids" or blood are frequently given to a patient by way of his veins. Glucose (sugar) and saline (salt) solutions are the commonly used "fluids". Common amounts are 500 c.c.; 1000 c.c.; 1500 c.c.

6. The amount of urine obtained by catheterization, is usually measured in ounces or c.c.

7. It is usually a good plan on the part of the corps man to measure the amount of blood coughed up or vomited, because it is exceedingly difficult to judge (guess) the amount. An accurate measure may help the medical officer to make a diagnosis.

8. In some diseases, fluid or pus accumulates within body cavities (pleural, pericardial or peritoneal) or joints. Fluid or pus is usually measured on removal.

9. To make solutions.

EXERCISE 35

(Do in Class)

1. A patient drinks 2720 c.c. of fluid.
 - a) Express this amount in liters.
 - b) Express this amount in ounces.
2. A patient voids 9.2 ounces of urine. Express in c.c.
3. Reduce .8 pints to ounces.
4. Reduce .8 ounces to drams.
5. Reduce .4 drams to minims.
6. How many minims in 1.65 fluid ounces?
7. Convert 375 c.c. into fluid ounces.
8. Convert 0.3 c.c. into minims.
9. Convert 4 f. oz., .2 f. dr. into c.c.
10. Convert 8 minims into c.c.
11. Convert 500 c.c. into fluid ounces.
12. Convert 20 oz. into c.c.
13. Convert 8 fluid ounces into fluid drams.
14. You are given a 4 oz. bottle of cough medicine. How many days will it last if you take $\frac{1}{3}$ three times a day?

15. There are normally about 5,000,000 red blood cells (R.B.C.) in a cubic millimeter ($\frac{1}{1000}$ of a c.c.) of blood.
How many are there in 5 liters of blood?
16. There are normally about 8,000 white blood cells (W.B.C.) per cubic millimeters of blood. Find number in 5 liters of blood.
17. A patient develops pneumonia. His W.B.C. count is found to be 26,000 per cubic millimeters. Find the number of W.B.C. in 5 liters. How many cells above the normal are there?

THE GRAM

One c.c. of distilled water at 4° C weighs 1 gram (Gm.). Therefore 1 liter of distilled water at 4° C weighs 1000 gms. Here then we comprehend the close inter-relationship that exists between the linear, capacity and weight system.

The gram is divided into:

Tenths, called decigrams (dg.)

Hundredths, called centigrams (cg.)

Thousandths, called milligrams (mg.)

The multiples of a gram are:

10 grams, called decagrams (Dg.)

100 grams, called hectogram (hg.)

1000 grams, called kilogram (kg.)

10,000 grams, called myriagram (Mg.)

The metric system when compared to the apothecary weight system, shows:

$$1 \text{ oz.} = 8 \text{ drams.}$$

By actual comparison 1 oz. of distilled water at 4⁰ C. weighs 31.1 grams.

There ~~is~~ ^{are two} ~~one~~ approximate values frequently used.

1 dram = 4 grams (one teaspoonful)

$\frac{1}{2}$ ounce = 16 grams (one tablespoonful)

In contrast to the liquid measures where fluid ounces are frequently used, there is this general custom in the weight system. Weights are expressed almost wholly in grams, thus adhering closely to the metric system. For example 480 Gm. is expressed as 480 Gm. No attempt is made to reduce 480 Gm. to ounces.

Moreover, a dram or teaspoonful of dry measure is given the approximate value of 4 Gm. A tablespoonful is 16 grams.

In Europe, food is bought by the gram and its multiples; while in America and England we buy by the pound and ounce.

THE GRAIN

In England, long ago before there was a metric system, the wheat grain "well dried and gathered out of the middle of the ear", was made the standard for the grain weight. Drugs and fine metals were measured in grains.

Some drugs were effective in doses of 5-10 grains. To measure out this amount would not be difficult. Certain drugs, however, produced the desired therapeutic effects when very small amounts were used. But how was an apothecary to measure out 1/100 of grain to be used as a single dose?

Two methods were commonly used; one, by the use of powders, another, by the use of solutions.

For example. A patient may have required $1/100$ of grain of some drug, to be taken three times a day. Without delicate scales to measure $1/100$ of a grain, the apothecary could solve this problem by placing 1 grain of the drug and 99 grains of milk sugar in a bowl. After thoroughly mixing, he had 100 grains of powder, in which there was 1 grain of medicine. Since:

100 grains of powder contained 1 grain of drug:

Then

1 grain of powder contained $1/100$ grain of drug.

This method of mixing the drug with some powder, such as milk sugar, was a common means of meeting the problem. By dividing the 100 grain mixture into 100 equal parts, each part would weigh 1 grain, in which there would be $1/100$ grain of medicine.

Another method employed the use of a solution. That is, 1 grain of a drug is placed in a calculated amount of fluid, such as water, so that a teaspoonful will contain $1/100$ grain of the medicine. In this case, 100 teaspoons of water would be the necessary amount.

One of the very important drugs of today and several hundred years ago, is digitalis. It is of great value in certain types of heart disease.

Digitalis extracted from a certain plant, was not always of the same strength. This being the case, it was impossible to state the amount of digitalis a patient should be given to obtain benefit, without poisoning, which results when too much of the drug is given. Because the drug varied in potency, the effects varied. To be sure the good effects would be obtained, digitalis was given to the patient until certain signs of poisoning occurred; then after the drug had been withheld several days or more, a fraction of the original

amount was given daily. Without a standard of potency, the physicians were forced to follow some rule, even though it was broad rather than exact. Therefore, the custom was for the patient to take a certain number of drops of the solution daily, until he "puked or purged", which indicated the early effects of poisoning.

When the metric system was introduced the gram was promptly compared to the grain. On measuring it was found that:

$$1 \text{ gram} = 15.432 \text{ grains.}$$

$$= 15.0 \text{ grains (approximate value)}$$

But what did 1 grain equal?

$$1 \text{ gm.} = 15.432 \text{ grains}$$

Therefore

$$1 \text{ grain} = \frac{1 \text{ Gm.}}{15.432}$$

$$= 0.065 \text{ Gm.}$$

$$= 0.06 \text{ Gm (approximate value)}$$

This equivalent is very important as it is the basis for converting one system to the other. You will note that 1 grain is roughly equal to 0.06 Gm. - a little more than .05 Gm. and not as much as 0.1 Gm. which would be an easier figure to deal with.

How to find equivalents.

Example.

If 1 grain equals 0.06 Gm., find the metric equivalent of 0.1 grain

Method

$$\text{Since } 1 \text{ grain} = 0.06 \text{ Gm.}$$

$$1/10 \text{ grain} = 1/10 \text{ of } 0.06 \text{ Gm.}$$

$$.1 \text{ grain} = 0.006 \text{ Gm.}$$

Example:

If 1 Gm. equals 15.0 grains, find the metric equivalent of $\frac{1}{2}$ Gm.

Method:

$$1 \text{ Gm.} = 15.0 \text{ grains.}$$

$$1 \text{ Gm} \div 2 = 15.0 \text{ grains} \div 2.$$

$$\frac{1}{2} \text{ Gm.} = \frac{15.0}{2} \text{ grains.}$$

$$\frac{1}{2} \text{ Gm.} = 7\frac{1}{2} \text{ grains}$$

Example:

Find the metric equivalent of 10 grains (as 10 grains of asperin).

Method:

$$1 \text{ grain} = 0.06 \text{ Gm.}$$

$$10 \text{ grains} = 10 \times 0.06 \text{ Gm.}$$

$$= 0.6 \text{ Gm.}$$

Example:

Find the metric equivalent of $\frac{1}{150}$ of a grain ?

Method:

$$1 \text{ grain} = 0.06 \text{ Gm.}$$

$$\frac{1}{150} \text{ of one grain} = \frac{1}{150} \text{ grain.}$$

Therefore

$$\frac{1}{150} \text{ grain} = \frac{0.06 \text{ Gm.}}{150}$$

$$= 0.0004 \text{ Gm.}$$

Example:

Find the apothecary equivalent of 0.0004 Gm ?

$$1 \text{ gram} = 0.06 \text{ Gm.}$$

$$? = 0.0004 \text{ Gm.}$$

0.0004 Gm. is what part of 0.06 Gm.?

$$\begin{array}{r} .0004 \overline{) 0.0600} \\ \underline{4 } \\ 20 \\ \underline{20} \end{array}$$

.0004 Gm. is one hundred and fiftieth ($\frac{1}{150}$)
of 0.06 Gm.

Therefore

since 0.0004 Gm. is $\frac{1}{150}$ of 0.06 Gm.

and

since 1 grain = 0.06 Gm.

Then

$$.0004 \text{ Gm.} = \frac{1}{150} \text{ grains.}$$

In the hospital the metric system of measures is used to weigh the following:

1. Objects that are apt to weigh a gram or over.

a. Food. The patient with diabetes mellitus is taught to weigh all the food he eats. The exact way to do this is to weigh the food, using metric measures. A rough way is to use the teaspoon and tablespoon.

b. Chemicals In the laboratory, various solutions are made and used. This involves the very careful measuring of chemicals.

- c. Pathological specimens. Stones and tumors are examples of specimens weighed after removal.
- d. Organs removed at post-mortem. The average weight of organs is known. Variations in size due to disease or arrested development are most accurately ascertained by weighing the organs. Examples are: spleen, kidneys, adrenals, heart, etc.
- e. Drugs. In the pharmacy, large quantities of certain commonly used solutions, which are called "stock solutions", are made. These solutions usually require the use of drugs in amounts of a gram or more.

The same is true for the making of ointments, salves, pastes, etc.

2. Objects that are apt to weigh a gram or less.

- a. In this category are most of the commonly used drugs.

EXERCISE 36

(Do in Class)

Convert the following to the metric system:

- 1. 10 grains.
- 2. $7\frac{1}{2}$ grains
- 3. $1/200$ grain.
- 4. $1/50$ grain.
- 5. $1/75$ grain.
- 6. $1/6$ grain.
- 7. $1/4$ grain.
- 8. $1/2$ grain.

Exercise 36 (Continued)

9. $\frac{1}{8}$ grain.
10. $\frac{1}{150}$ grain.
11. 15 grains.
12. 5 grains.
13. $\frac{1}{10}$ grain.
14. $\frac{1}{16}$ grain.
15. $\frac{1}{1000}$ grain.

EXERCISE 37

Convert the following:

1. 30 mg. to Gm.
2. .6 mg. to Gm.
3. 8 mg. to Gm.
4. 500 mg. to Gm.
5. .0004 Gm. to mg.
6. .015 Gm. to mg; to grains.
7. .3 mg. to Gm; to grains

Complete the following table:

30 grains equal	Gm.	mgm.
15 " "	"	"
10 " "	"	"
$7\frac{1}{2}$ " "	"	"
5 " "	"	"
1 grain equals	"	"
$\frac{1}{2}$ " "	"	"

Complete the following table (Continued)

$\frac{1}{4}$	grain equals		Gm.	mgm.
$\frac{1}{6}$	"	"	"	"
$\frac{1}{8}$	"	"	"	"
$\frac{1}{10}$	"	"	"	"
$\frac{1}{12}$	"	"	"	"
$\frac{1}{16}$	"	"	"	"
$\frac{1}{50}$	"	"	"	"
$\frac{1}{75}$	"	"	"	"
$\frac{1}{100}$	"	"	"	"
$\frac{1}{150}$	"	"	"	"
$\frac{1}{200}$	"	"	"	"

NOTE:

In the hospital the doses of drugs are expressed in the metric system. However, at times the apothecary system is used. Because both "languages" are used in this country one should be familiar with both.

CHAPTER VII

The Thermometer

There is a difference between heat and temperature, which should be clearly understood. A quart of water at 212° Fahrenheit is just as hot as a barrel of water at 212° Fahrenheit because the temperature is the same, but the quantity or amount of heat in the barrel of water is very much greater than in the quart of water. The intensity of heat is known as its temperature, the degree of intensity is determined by instruments called thermometers and is expressed relatively in degrees.

A thermometer is a glass tube with a very small bore, sealed at one end and the other end terminating in a bulb which is usually filled with mercury. When subjected to the influence of heat the mercury expands and rises in the tube, the degree of heat being read on a graduated scale marked on the tube.

The three scales used in marking thermometric degrees are Fahrenheit, Centigrade, and Réaumur. In the Fahrenheit scale the freezing point of water is 32° , the boiling point is 212° , and the intervening space is divided into 180 degrees. In the Réaumur scale the freezing point of water is zero, the boiling point is 80° , and the intervening space is divided into 80 degrees. The Réaumur scale is rarely used in English-speaking countries. Most thermometers in use in the United States are graduated either in the Centigrade or the Fahrenheit scale, and some thermometers have both scales.

"It is often necessary to convert the degrees of one scale into those of another, and in converting Centigrade degrees into Fahrenheit degrees or vice versa, it should be kept in mind that 100 degrees Centigrade are equal to 180 degrees Fahrenheit, or that 1° C. is equal to 1.8° F. It should also be kept in mind that on the Fahrenheit scale the freezing

point of water is 32 degrees above zero or 32 degrees higher than on the Centigrade scale, and this difference of 32 degrees must be considered".

RULES FOR CONVERSION

With temperatures above the freezing point of water, to convert Fahrenheit degrees to Centigrade degrees the rule is: Subtract 32 from the number of Fahrenheit degrees and divide the remainder by 1.8.

Example:

Convert 122° F. to Centigrade.

Method:

$$122 - 32 = 90.$$

$$90 \text{ divided by } 1.8 = 50$$

$$50^{\circ} = \text{answer}$$

With temperatures above the freezing point of water, to convert Centigrade degrees to Fahrenheit degrees the rule is: Multiply the number of Centigrade degrees by 1.8 and to the product add 32.

Example:

Convert 50° C. to F.

Method:

$$50 \times 1.8 = 90$$

$$90 + 32 = 122$$

$$122^{\circ} = \text{answer}$$

With temperatures below the freezing point of water, to convert Fahrenheit degrees to Centigrade degrees the rule is: Add 32 to the number of degrees below the freezing point and divide the sum by 1.8.

Example:

Convert -31°F to C.

Method:

$$31 + 32 = 63$$

$$63 \text{ divided by } 1.8 = 35$$

$$- 35^{\circ}\text{C} = \text{answer.}$$

With temperature below the freezing point of water, to convert Centigrade degrees to Fahrenheit degrees, the rule is: Multiply the number of degrees below the freezing point by 1.8 and from the product subtract 32.

Example:

Convert -35°C to F.

Method:

$$35 \times 1.8 = 63$$

$$63 \text{ minus } 32 = 31$$

$$-31^{\circ}\text{F} = \text{answer}$$

There is a simpler method of conversion, which it is well to present after having studied the above. The rule is:

To convert Fahrenheit to Centigrade, subtract 32° and multiply the result by $5/9$.

To convert Centigrade to Fahrenheit, multiply by $9/5$ and add 32° .

THERMOMETER - COMPARATIVE SCALES

Centi- grade	Fahrenheit		Centi- grade	Fahrenheit	
		Water boils at sea level			
100°	212°			98.6	Blood heat
	194			95.	
	185			90	
	174			86	
	167	Alcohol boils		80	
	158			77	
	149			68	
	140			60	
	131			55	
	127	Tallow Melts		50	
	122			45	
	113			35	
	108			32	Water freezes
	104			30	
				23	
				20	
				14	
				0	Zero Fahrenheit
				- 4	
				-13	
				-22	
				-31	
				-40	

Table I

EXERCISE 38

1. Convert the following Fahrenheit degrees to Centigrade, and record in the above table.

167° F 104° F 60° F 0° F -40° F
140 F 98.6 F 32 F -22 F

2. Convert the following Centigrade degrees to Fahrenheit:

99° C 15° -5° C
39° C 16° -25° C

3. The average temperature on the surface of the sun has been estimated at 6,000° C. Convert to F. degrees.

4. Convert the following C degrees to F and record.

Boiling points of several chemicals

Element	C°	F°
Antimony	1,380	
Argon	-185.7	
Carbon	4,200	
Helium	-268.9	
Iron	3,000	
Lead	1,620	
Magnesium	1,100	
Platinum	4,300	
Tin	2,270	
Tungsten	5,900	

CHAPTER VIII

1. Per cent

2. Solutions

1. Per cent.

"Per cent" is a new word for you in the language of arithmetic. It means per 100. Suppose a man borrows \$100. The bank informs him that the interest amounts to 3 per cent. Translated, this means that the cost (interest) of borrowing \$100 is 3 per hundred or \$3.00.

\$100 = amount borrowed

\$ 3 = cost, at a rate of 3 per cent interest.

The short hand expression for "per cent" is %, so that 3 per cent can be expressed as 3%.

"Per cent" can also be expressed as a decimal fraction.

3% is the same as .03

"Per cent" can, moreover, be expressed as a common fraction.

3% is the same as $\frac{3}{100}$.

If these equivalents were written down, we could note that \$3 is a part of \$100 and can be expressed in a number of ways.

No. of dollars	Common Fraction	Decimal Fraction	Per Cent
3	$\frac{3}{100}$	.03	3%

To be sure this is understood, a few more examples are given below:

$$\begin{aligned}10\% &= 10/100 = .1 \\25\% &= 25/100 = .25 \\150\% &= 150/100 = 1.5\end{aligned}$$

Examples:

1. Find 6% of 40

$$40 \times .06 = 2.4$$

2. Find 150% of 30

$$30 \times 1.50 = 45$$

A value expressed as a common fraction may be expressed as a decimal fraction by dividing the numerator by the denominator. For

example, $\frac{1}{2} = .5$

A per cent may be converted into a decimal fraction by moving the decimal point to the left two places and eliminating the per cent sign. Thus $75\% = .75$

The decimal fraction may be converted into a common fraction by placing the indicated denominator under the numerator and reducing the result to a common fraction in lowest terms. Thus;

$$.75 = 75/100 = 3/4$$

EXERCISE 39

Convert the following:

	Common Fraction	Decimal Fraction	Per Cent
a.	$1/2$		
b.	$1/4$		
c.	$2/3$		
d.	$2/5$		
e.	$3/4$		
f.	$1/8$		
g.	$3/16$		
h.	$3/7$		
i.	$5/8$		

EXERCISE 40

Convert the following:

	Per Cent	Decimal Fraction	Common Fraction
a.	30%		
b.	$12\frac{1}{2}\%$		
c.	25%		
d.	5%		
e.	$66\frac{2}{3}\%$		
f.	75%		
g.	90%		
h.	$6\frac{1}{4}\%$...		
i.	$37\frac{1}{2}\%$..		
j.	50%		
k.	40%		
l.	$87\frac{1}{2}\%$...		

EXERCISE 41

Do the following:

- | | |
|----------------------|----------------------|
| 1. $64 \times 50\%$ | 7. $16 \times 25\%$ |
| 2. $45 \times 20\%$ | 8. $9 \times 10\%$ |
| 3. $80 \times 3\%$ | 9. $90 \times 8\%$ |
| 4. $120 \times 8\%$ | 10. $67 \times 2\%$ |
| 5. $200 \times 12\%$ | 11. $400 \times 6\%$ |
| 6. $15 \times 5\%$ | 12. $14 \times 18\%$ |

EXERCISE 42

1. A man weighs 150 pounds. His body is composed of the following chemicals. Find, in grams, the amount of each.

	Per Cent	Grams
Oxygen - -	65	- -
Carbon - -	18	- -
Hydrogen - -	10	- -
Nitrogen - -	3	- -
Phosphorus - -	1	- -
Sulfur - -	0.25	- -
Chlorine - -	0.15	- -
Sodium - -	0.15	- -
Potassium - -	0.35	- -
Calcium - -	2.00	- -
Magnesium - -	0.05	- -
Iron - -	0.004	- -
Other elements -	0.046	- -

2. A potato weighing 100 Gm. contains the following: (Express in Gm.)

Carbohydrate - -	19%	- - -
Protein - - - - -	2%	- - -
Fat - - - - -	0%	- - -

3. A piece of bread weighing 30 Gm. contains the following:
(Express in Gm.)

Carbohydrate - - -	18%
Protein - - - - -	3%
Fat - - - - -	0.7%

Find the amounts of each in 100 Gm. of bread.

2. SOLUTIONS

A solution is made by dissolving a solid in a liquid. Two solutions commonly used in the wards are glucose (sugar) solutions and saline (salt) solutions. Those patients who are in need of such solutions, ^{can} receive them directly into their own veins.

There are many, many solutions. The laboratory has need of a great variety in order to do work that involves chemical analysis. The pharmacy makes many of the solutions used in the wards, such as cough medicines, "nose drops", "eye drops", intestinal medicines, and so on. Large pharmaceutical houses, as a rule, prepare glucose and saline solutions.

When a solid as ephedrin (chemical) is dissolved in salt water, the solution is called a saline solution of ephedrin.

If the ephedrin were dissolved in water, the solution would be referred to as an aqueous solution of ephedrine.

At times alcohol is used as the liquid, because the solid will dissolve more satisfactorily in alcohol than water.

It is important to understand the language that deals with the strength of solution. What is a 1% solution, a 50% solution, and so on?

A 1% solution is one which contains 1 Gm of the solid in every 100 c.c. of the solution.

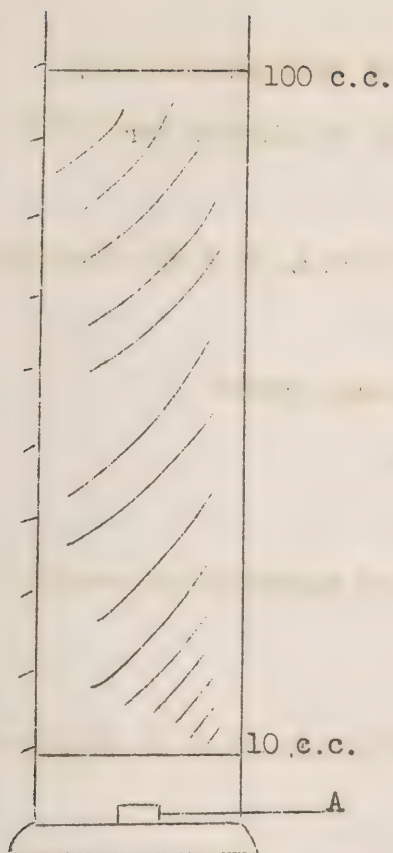


Fig. 4

The preparation of a 1% solution

To make a 1% saline solution,

Place exactly 1 Gm. of salt (A) in the container.

Then add water until the water level in the container reaches the 100 c.c. mark.

After the water has been shaken to aid in the dispersal of the salt, 100 c.c. of the solution contains 1 Gm of salt. This is a 1% saline solution.

This method is one way of making a 1% saline solution. Another way would be to add the water to a special flask, a flask that is accurately calibrated by the Bureau of Standards. The resulting solution would be very accurate. Such accuracy is needed in some types of work as well as in the preparation of some medicinal solutions. Saline solutions that are given by vein, are very accurately prepared.

To make a liter of 1% saline solution, requires the addition of 10 Gm of salt followed by the addition of enough water to come "up to" the 1000 c.c. mark.

If 1000 c.c. contains 10 Gm salt

Then 100 c.c. contains 1 Gm salt

and this is a 1% solution.

A 10% solution of salt contains 10 Gm. of salt per 100 c.c.

A 50% solution of glucose contains 50 Gm. of glucose per 100 c.c.

Problem. How much phenol is needed to make 50 c.c. of a 5% solution?

Method:

50 c.c. of a 5% solution contains how many grams?

100 c.c. of 5% solution contains 5 Gm.

Therefore,

50 c.c. or one-half of 100 c.c. contains one-half the amount
of phenol, namely 2.5 Gm.

Problem. How much phenol is needed to make 60 c.c. of a 3% solution?

One Method.

60 c.c. of a 3% solution contains how many grams?

100 c.c. of a 3% solution contains 3 Gm.

60 c.c. is $\frac{3}{5}$ of 100 c.c.

Therefore,

$\frac{3}{5}$ of 3 Gm = amount of phenol in 60 c.c.

1.8 Gm = answer

Second Method

100 c.c. of a 3% solution contains 3 Gm.

1 c.c. of a 3% " " .03 Gm.

60 c.c. of a 3% " " 1.8 Gm. (60 x .03)

Stock Solutions.

The pharmacy usually has on hand large amounts, perhaps 5000 c.c. of certain solutions. Such solutions are stronger than those prescribed. Suppose that 1/4% ephedrin solution was commonly used in the wards. The pharmacy might keep on hand 5000 c.c. of a 1% solution. As requests were made for 1/4% strength, the pharmacists would dilute some of the 1% solution to 1/4% strength and dispense it.

Suppose you wished to make a solution of 50% strength from a solution of 100% strength. The easiest way is to measure out equal amounts of water and 100% solution and mix them together. You then have a 50% solution. This is practical if you always have a 100% solution, which you rarely have.

To make 100 c.c. of a 25% solution of phenol from a 50% stock solution of phenol is the type of problem that comes up.

Method

100 c.c. of a 25% solution contains 25 Gm phenol

100 c.c. of a 50% solution contains 50 Gm phenol

We want 100 c.c. of a 25% solution or 25 Gm. phenol
In a 50% solution.

1 c.c. contains 1/100 of 50 Gm = 0.5 Gm phenol.

How many c.c. of 50% solution contains 25 Gm?

$$25 \text{ Gm} \div 0.5 \text{ Gm} = 50 \text{ c.c.}$$

or

(1 c.c. of a 50% solution contains 0.5 Gm.)

(50 c.c. " " " " " 25.0 Gm.)

Put 50 c.c. of a 50% solution (25.0 Gm.) into a glass beaker and add enough water to make 100 c.c. This gives 100 c.c. of solution in which there are 25 Gm., making it a 25% solution of phenol.

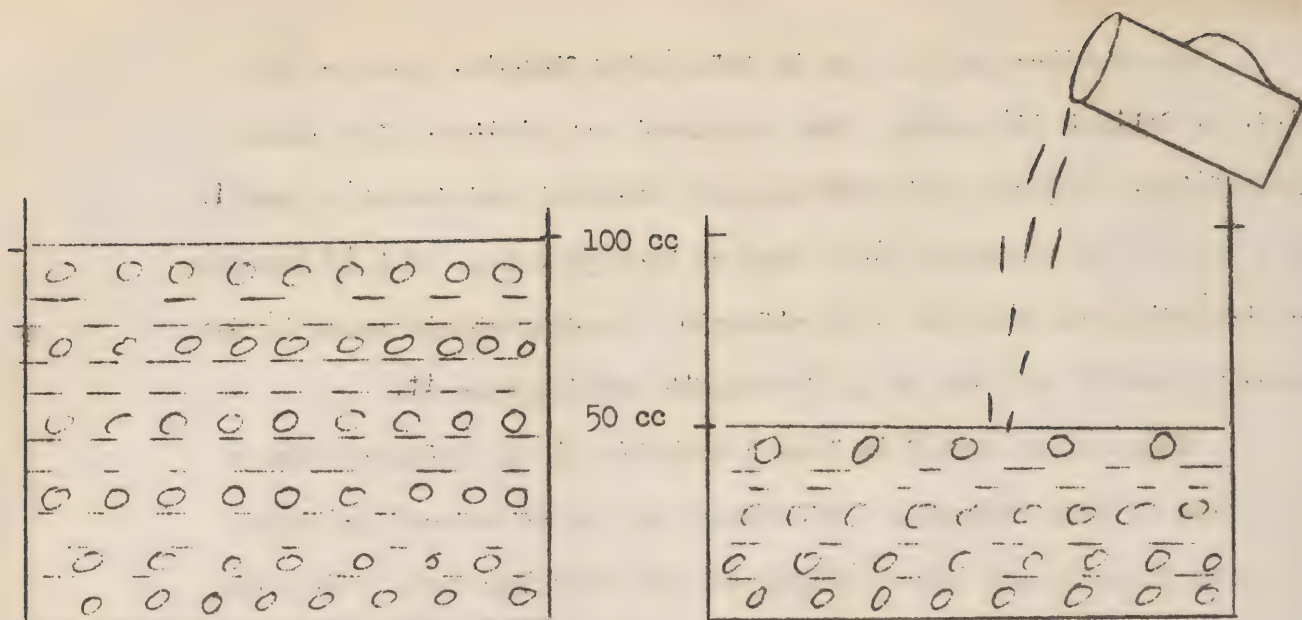


Fig. 5

The figure on the left represents 100 c.c. of 50% solution of phenol, in which are 50 Gm. of phenol. The figure on the right represents a container with 50 c.c. of a 50% solution containing 25 Gm. phenol. Into it are being poured 50 c.c. of water. This will make a 100 c.c. solution, in which are 25 Gm. of phenol; thus creating a 25%.

Problem

Make 1000 c.c. of a 25% from a 50% stock solution.

Method

1000 c.c. of a 25% solution contains 250 Gm.

100 c.c. of a 50% solution contains 50 Gm.

We want 1000 c.c. of a 25% solution or 250 Gm.

In a 50% solution

1 c.c. contains $1/100$ of 50 Gm = 0.5 Gm. phenol.

How many c.c. of stock solution contain 50 Gm.?

$$250 \text{ Gm.} \div 0.5 \text{ Gm} = 500 \text{ c.c.}$$

Put 500 c.c. of a 50% solution into a beaker and add enough water to make 1000 c.c. This gives 1000 c.c. of solution, in which there are 50 Gm., making it a 25% solution.

To make a formula.

$$\frac{\% \text{ desired}}{\% \text{ of stock sol.}} \times \text{number c.c. desired} = \text{number of c.c. of stock solution to use.}$$

$$\frac{25\%}{50\%} \times 1000 = \frac{25000}{50} = 500 \text{ c.c.}$$

500 c.c. stock sol. to use.

EXERCISE 43

1. Make 1000 c.c. of a 2% solution of phenol from a 25% solution.
2. How many grams of boric acid are there in 500 c.c. of 2% solution?
How many grains?
3. How many grams of silver nitrate in 700 c.c. of a 2.5 % solution?
4. How many grains of silver nitrate are there in 6 fluidounces of a 10% solution?
5. How much salt is needed to make 250 c.c. of 1% solution?
6. A man of 150 pounds' weight has about 5 liters of blood. The blood sugar (amount of sugar in the blood) is 0.1 gm. %. Find the amount of sugar in his blood.

7. How much salt does the blood contain if the blood salt is .45 gm.% ?
8. How much stock solution is needed to make 30 c.c. $1/4$ % ephedrin solution from a 1% stock solution?
9. How many teaspoons of salt are needed to make a liter of a 1% saline solution?

CHAPTER IX.

FOOD AS ENERGY

"A man is continually giving out energy. He is never completely at rest as long as he is alive. Even during sleep his limbs twitch, his ribs rise and fall with respiration, and his heart continues to beat regularly. Besides these movements, there is another way in which he loses energy. It takes energy to keep his body warm. A hot piece of metal or stone will, in a short time, cool down to the temperature of the surrounding air, but a living body is always warm to the touch. A man, like any warm object, loses heat continually to the cooler air which surrounds him."

"We can measure the amount of food that a man or an animal consumes over a given period of time, and we can measure the energy yielded during the same period. If we burn an equal weight of similar food in a suitable apparatus and find out how much energy its combustion yields, and if this value is equal to the energy yielded by the experimental subject, then evidently the living organisms, so far as its energy-output is concerned, is really and precisely a combustion engine (like a gasoline engine)."

"Such experiments have been performed. A man has been shut up for a time in a small compartment, so constructed that the energy he gave out, as heat or otherwise, could be accurately measured. He was fed on a weighed amount of food of known composition and the energy actually yielded was compared with that which would have been obtained had the food been simply burnt." In a typical experiment, it was found that a man gave out 2,682 calories of heat and ate an amount of food which would yield, if burnt, 2,688 calories. The two sums differ by less than 1/4 of 1%, which is within the margin of error of the methods employed. We can say, therefore, that man is fundamentally a machine driven by the energy

that is produced from the burning of food. "A mouse or a man works in much the same manner as a gasoline engine; its fuel is its food; and like a gasoline engine, if it lacks either fuel or air, it will cease to move, and slowly becomes cold."

Food is fuel, as is gasoline. The automobile engine is driven by gasoline when the gasoline is combusted. As it burns it yields energy.

When food is burned it yields heat, which is the same as energy. Instead of using the word burn when we speak of food, we say that food is oxidized.

We must find some standard to measure heat, just as we have found standards to measure distance, weight, volume. The unit of heat is the large calorie. A calorie is the amount of heat required to raise 1000 c.c. of distilled water from 15° to 16° C.

As mentioned above heat is energy. Food produces energy while body warmth and movements of muscles use up energy.

By experiment it has been found that:

1 gram of carbohydrate yields...4 calories

1 gram of protein yields 4 calories

1 gram of fat yields 9 calories

This information gives us the opportunity to discover how many calories we derive from the food we eat.

Moreover, it has been found, by experiment, how many calories are used up in various types of work and play; in sleep, in health and in disease.

For instance:

A person at bed rest needs about 1800 calories per day.

A clerk needs about - - - - 2200 " " "

A carpenter needs about - - - 3200 " " "

A stone mason needs about - - 4400 " " "

A lumberman needs about - - - 6000 " " "

Calories required by a marching soldier.

<u>Load</u>	<u>Road</u>	<u>Normal Needs</u>	<u>Extra Work</u>	<u>Total</u>	<u>10% for waste</u>
0	Level or rolling	2064	900	2964.	3260
50 lb.	" " "	2064	1172	3236	3560
50 lb.	Ascending 100 ft. per mile	2064	2110	4174.	4590

The above gives a rough estimate of caloric needs. More calories are needed in a long march than in a short one. Since no distance is stated, these figures represent only a rough idea of how calorie needs vary with types of work or exercise.

Nothing has been said about the body's need of minerals and vitamins. Such a discussion is beyond the scope of a study of the energy value of food.

Classification of foods

1. Carbohydrates. Sugar is an example of pure carbohydrate. Bread is about 50 - 70% carbohydrate.
2. Protein. Meat, fish, and poultry are examples.
3. Fats. Butter, olive oil and meat fat are examples of fat.

Method of calculating calories

1. A man takes 2 teaspoonfuls (8 Gm) of sugar in his coffee. How many calories does he obtain from the sugar?

4 calories in one (1) Gm.

$$4 \times 8 = 32 \text{ calories}$$

2. A man eats 150 Gm. of string beans for lunch. The composition of string beans is as follows:

Carbohydrate	Protein	Fat
%	%	%
7.7	2.4	0.2

Calculations:

% x amount = total Gm x calories per Gm = Calories

$$7.7 \times 1.5 = 11.5 \text{ Gm.} \times 4 = 46 \text{ cal.}$$

$$2.4 \times 1.5 = 3.6 \text{ Gm.} \times 4 = 14.4 \text{ cal.}$$

$$.2 \times 1.5 = .3 \text{ Gm.} \times 9 = 2.7 \text{ cal.}$$

= 63.1 calories from
string beans.

Problem

On the following page is a list of foods that would make an adequate diet.

Calculate the number of calories that each food yields. When all caloric equivalents have been calculated, add them up. The sum total will be the total number of calories provided by these foods.

ANALYSIS OF AN ADEQUATE DIET

FOOD	Wt. in Gms.	Equivalents Household measure	C H %	Protein %	Fat %	Calories	
Milk, whole	960	1 quart	5.	3.3	3.8		
Bread, whole wheat	150	5 thick slices	50	9.7	.9		
Egg	50	1 whole	-	13.4	10.5		
Butter	45	3 tablespoons	-	1.	85		
Meat, fish, or poultry	120	1 large serving	-	20.	14		
Cereal, cooked	30	1 serving	67.	16.	7.2		
Fruit - apple	100	1 small	14.	.4	.5		
Vegetables							
10% string beans	100	3/4 cups	7.7	2.4	.2		
5% tomatoes	100	1 medium	3.9	.9	.4		
Potato (white)	100	1 small	18.4	2.2	.1		
Cream, 20%	120	1/2 cup	4.5	2.5	18.5		
Mayonnaise	13	1 tablespoon	3.0	1.5	78.0		
Sugar	45	3 tablespoons	100	-	-		
Pudding (rice custard)	100	1/3 cup	31	4.0	5.0		
						Total Calories	

REVIEW
EXERCISES AND PROBLEMS

EXERCISE 44

Use short cuts for the following:

(1)	(2)	(3)
a. $96 \times 12-1/2$	545×20	$72 \times 33-1/3$
b. 178×50	$1,572 \times 3-1/3$	$156 \times 8-1/3$
c. 880×125	$172 \times 2-1/2$	92×250
d. $48 \times 333-1/3$	$184 \times 12-1/2$	$1,266 \times 16-2/3$
e. $45 \times 33-1/3$	$1,946 \times 500$	$132 \times 166-2/3$
f. 56×40	$112 \times 62-1/2$	$93 \times 66-2/3$
g. $15 \times 6-2/3$	96×375	$160 \times 37-1/3$
h. 45×75	742×80	$12 \times 7-1/2$
i. $12 \times 7-1/2$	$159 \times 83-1/3$	$24 \times 87-1/2$
j. $328 \times 3-3/4$	74×90	14×625
k. $18 \times 666-2/3$	$152 \times 8-3/4$	$52 \times 37-1/2$
l. 88×125	$80 \times 87-1/2$	$144 \times 8-1/3$

EXERCISE 45

Subtract the following:

(1)	(2)	(3)
a. $\begin{array}{r} 78-7/12 \\ \underline{47-1/2} \end{array}$	$\begin{array}{r} 86-9/10 \\ \underline{53-3/5} \end{array}$	$\begin{array}{r} 57-7/15 \\ \underline{49-1/3} \end{array}$
b. $\begin{array}{r} 36-5/16 \\ \underline{22-1/4} \end{array}$	$\begin{array}{r} 83-4/7 \\ \underline{37-1/3} \end{array}$	$\begin{array}{r} 68-5/9 \\ \underline{54-1/6} \end{array}$

EXERCISE 45. (Continued)

c.	$\frac{79-11/12}{27-5/8}$	$\frac{46-17/18}{23-5/12}$	$\frac{49-5/8}{37-3/4}$
d.	$\frac{75-15/24}{67-5/6}$	$\frac{67-14/36}{19-4/9}$	$\frac{72-3/5}{53-5/8}$

EXERCISE 46

	(1)	(2)	(3)
a.	$48-3/4 \times 12-1/2$	$16-1/2 \times 16-1/5$	$120-1/2 \times 150-2/3$
b.	$88-2/3 \times 16-1/4$	$125-3/4 \times 35-3/8$	$141-7/15 \times 17-4/5$
c.	$196-5/6 \times 75-1/2$	$108-2/3 \times 9-1/6$	$80-1/10 \times 25-1/5$
d.	$65-1/7 \times 27-1/3$	$190-1/12 \times 48-1/6$	$27-7/12 \times 84-3/4$

EXERCISE 47

	(1)	(2)	(3)
a.	$13-1/2 \div 4-1/2$	$7-1/2 \div 6-3/7$	$8-1/3 \div 6-1/4$
b.	$37-1/3 \div 6-2/9$	$14-1/4 \div 4-1/2$	$11-5/9 \div 5-2/3$
c.	$28-3/4 \div 5-3/4$	$5-3/7 \div 1-4/7$	$8-8/15 \div 2-6/35$
d.	$37-1/2 \div 3-1/8$	$16-7/8 \div 6-3/7$	$28-4/5 \div 1-13/23$

EXERCISE 48

Express the following as fractions of 100.

	(1)	(2)	(3)
a.	$6-1/4$	20	$62-1/2$
b.	$8-1/3$	25	$66-2/3$
c.	10	$33-1/3$	75
d.	$12-1/2$	$37-1/2$	$83-1/3$
e.	$16-2/3$	50	$87-1/2$

EXERCISE 49

Read orally each number to be added. Then find the sum.

(1)	(2)	(3)
3578.1329	721.001	1925.1926
821.098	9.1	1898.1001
43.11	85.48	21.0001
6.9	2000.0002	10.01
2.1	5243.8755	2000.1444
75.16	2978.3519	2222.1866
<u>221.133</u>	<u>1795.2901</u>	<u>3198.7152</u>

EXERCISE 50

Carry to three places.

(1)	(2)
a. $13.487 \div 3.67$	$487.7 \div 25.574$
b. $134.57 \div 32$	$569 \div 234.67$
c. $1383.6 \div 84.5$	$.3945 \div 2.3875$
d. $1,3785 \div 13.89$	$4.85712 \div 2.374$

EXERCISE 51

Change the following values to decimals. Do orally.

(1)	(2)	(3)	(4)
a. $3/8 \%$	$.2 \%$	$1-3/4 \%$	$1/4 \%$
b. $1/12$ of 6%	$1/4$ of 8%	$.025\%$	$.1 \%$
c. $.16\%$	4%	3.2%	$.006 \%$

EXERCISE 51 (Continued)

- | | | | | |
|----|-------|---------|--------|---------|
| d. | $1/8$ | $14/50$ | $3/4$ | $1/5$ |
| e. | $3/6$ | $1/10$ | $3/10$ | $4/100$ |

EXERCISE 52

(1)

- a. $3-1/4 \times 14.76$
- b. $7-4/9 \times 15.642$
- c. $6.72 \times 19-3/8$
- d. $4.928 \times 25-15/16$
- e. $25.587 \times 12-2/3$

(2)

- a. $72-3/5 \times 144.78$
- b. $95.59 \times 101-7/11$
- c. $23-9/14 \times 14.721$
- d. $12-37/40 \times 106.78$
- e. $105.723 \times 15-17/18$

EXERCISE 53

(1)

- a. $16-4/5 \div 4/2$
- b. $14.5 \div 3-5/8$
- c. $47-17/50 \div 5.26$
- d. $19.994 \div 6-1/2$
- e. $17-3/4 \div 4.4375$

(2)

- a. $37.33-1/3 \div 4-2/3$
- b. $31.4 \div 17-4/9$
- c. $54.9875 \div 5-3/16$
- d. $132.09 \div 15-4/17$
- e. $16-5/8 \div 2.078125$

EXERCISE 54

Express

- 1. 1 week in hours.
- 2. 3 hours in minutes.
- 3. 4 days in hours.
- 4. 2 years in days.

EXERCISE 54 (Continued)

5. $2\frac{1}{2}$ minutes in seconds.
6. 48 hours in days.
7. 14 days in hours.
8. 360 seconds in minutes.
9. 96 hours in days.
10. 720 seconds in minutes.
11. 5,000 years in centuries.
12. 48 weeks in hours.
13. 3 centuries in days.
14. 1942 years in seconds.
15. 8240 c.c. in liters.
16. 8.4 meters in millimeters.
17. .03 meters in centimeters.
18. 38 grams in milligrams.
19. 100 c.c. as liters.
20. 90 c.c. as ounces.
21. 8 minims as c.c.'s.
22. .06 Gm. as grains.
23. 3 miles as kilometers
24. 6 feet as meters.
25. 10 inches as centimeters.
26. 4.26 liters as c.c.
27. 100° F. as C°
28. 90° C. as F.
29. 196° F. as C°
30. 3.5 grams in grains.

PROBLEMS

1. A man sick in bed, drinks 1 quart of milk during a 24 hour period. In addition he is given 2000 c.c. of a 10% solution of glucose (sugar). How many calories does he receive?
2. 59% of the body's weight is water. A man weighs 150 pounds. How many pounds are water.
3. A patient is to receive three times a day a teaspoonful of cough medicine. In each teaspoonful there is $1/4$ grain of codeine. How much codeine is there in 8 fluidounces of cough medicine? Express in grams, mgn., grains.
4. How would you prepare 300 c.c. of 60% alcohol from a stock solution of 95% ?
5. During a $7-1/2$ mile march a soldier perspires 1,200 c.c. of fluid. It requires 0.5 calorie to evaporate 1 c.c. of perspiration. How many calories are needed to evaporate 1,200 c.c.?
6. A certain soldier at rest requires 3000 calories per day, of which $1/5$ actually goes into work. The remainder is dissipated as heat. Express in calories the number needed for work and the number needed for the dissipation of heat.
7. A soldier weighing 160 pounds, carrying 40 pounds, and walking 15 miles at the rate of 3 miles per hour on a level surface will perform an amount of work equivalent to 350 foot-tons of work.

6.3 foot-tons of work require 4.1 calories.

Find the number of calories needed to do the foot-tons of work.

8. If the left ventricle pumps out 70 c c. of blood at each beat, and the heart rate is 70 per minute, find the amount of blood pumped by the ventricle per minute.
9. If during exercise, the rate increases to 120 per minute, what is the volume pumped per minute?
10. How many grams of sugar yield 3000 calories?
11. The circumference of the earth at the equator is 24.902 miles. Express in meters?
12. When it is noon in Greenwich, England, what time is it at:
 - a. Kiev, Russia - 30° E
 - b. Leningrad, Russia - 60° E
 - c. Calcutta, India - 90° E
 - d. Tokio, Japan - 140° E
 - e. Sydney, Australia - 150° E.
 - f. Attu Island, Alaska - 173° E.
 - g. Wellington, N. Z. - 174° E.
 - h. Dutch Harbor - 165° W
 - i. Sitka, Alaska - 135° W
 - j. San Francisco - 120° W
 - k. New Orleans - 90° W
 - l. New York - 75° W
 - m. Iceland - 20° W

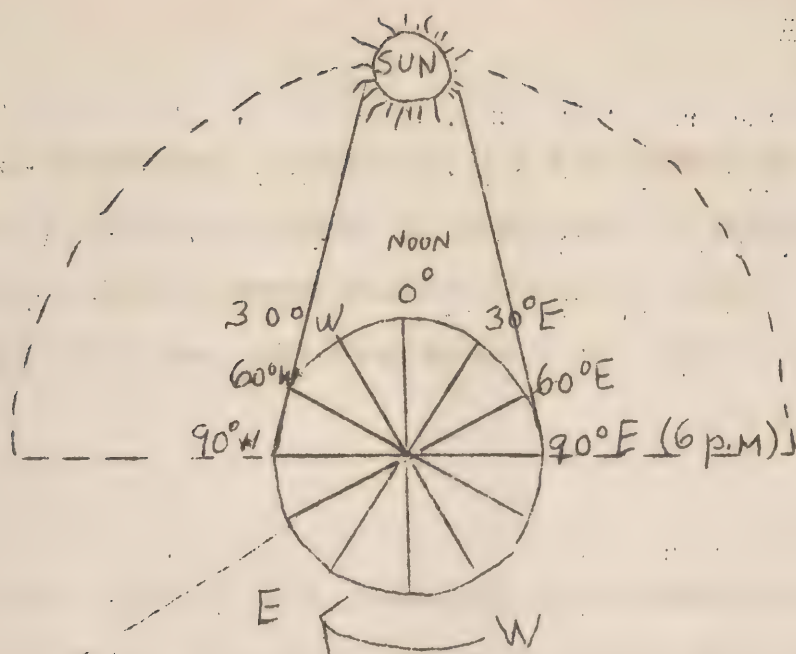


Fig 6

At noon the sun lies directly over Greenwich which is at 0° longitude. The earth rotates from West to East. It goes completely around 360° in 24 hours. When the earth moves eastward, the western longitudes come directly under the sun's rays. Before doing the problems, it is necessary to find how many degrees the earth moves in some unit of time, as an hour.

TABLES

MULTIPLICATION AND DIVISION TABLE

Multiplication

To find the product of 8×9 , for example, first locate on the top line, the number 9. Next locate the number 8 on the left hand vertical line. Lastly, follow the 9 column downward until it meets the extension of the 8 line. The 9 column and 8 line meet at 72, which is the product of 8×9 .

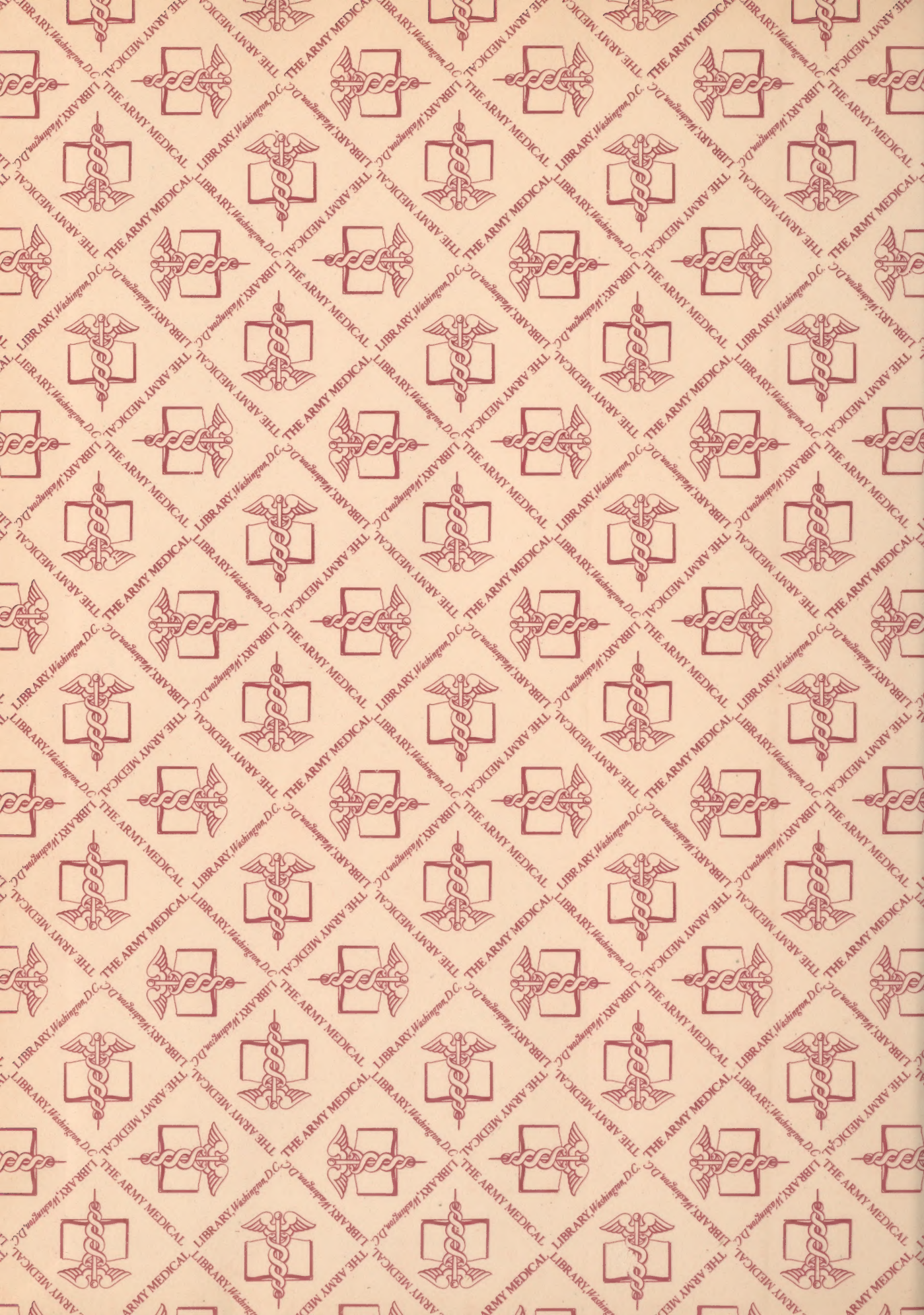
Division

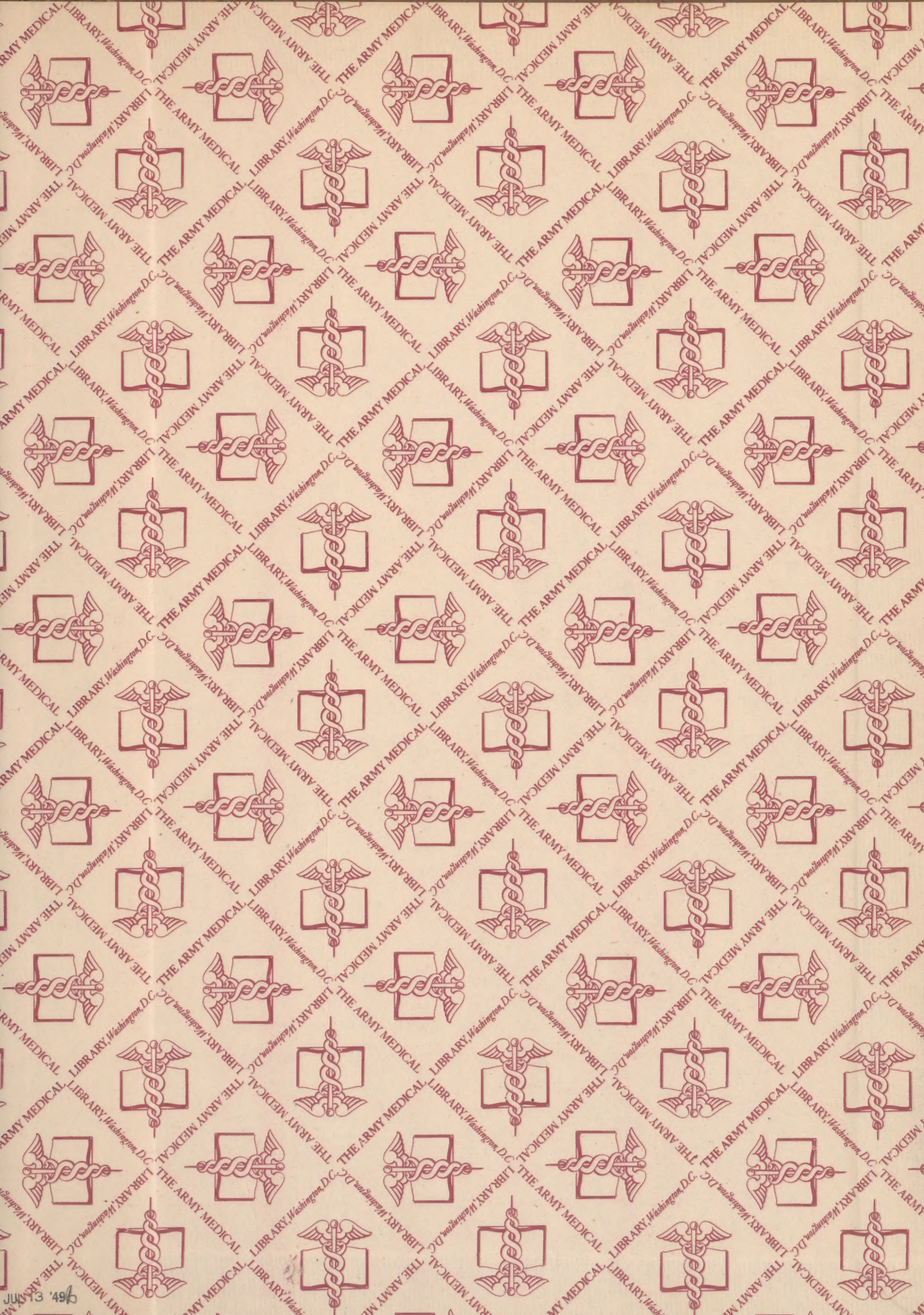
To find what numbers when multiplied, give 72, first locate 72. Next follow the column upward to the end, which is 9. Next follow the line from 72, to the extreme left, to 8. 8 and 9 are the answers.

$72 \div 9 = ?$ Find 72. Locate 9 at the end of the vertical column. Next follow the horizontal line to the extreme left. The answer is 8.

1	2	3	4	5	6	7	8	9	10	11	12
2	4	6	8	10	12	14	16	18	20	22	24
3	6	9	12	15	18	21	24	27	30	33	36
4	8	12	16	20	24	28	32	36	40	44	48
5	10	15	20	25	30	35	40	45	50	55	60
6	12	18	24	30	36	42	48	54	60	66	72
7	14	21	28	35	42	49	56	63	70	77	84
8	16	24	32	40	48	56	64	72	80	88	96
9	18	27	36	45	54	63	72	81	90	99	108
10	20	30	40	50	60	70	80	90	100	110	120
11	22	33	44	55	66	77	88	99	110	121	132
12	24	36	48	60	72	84	96	108	120	132	144

This table is to be memorized.





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